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NEW AND LITTLE KNOWN SHARKS FROM THE ATLANTIC AND FROM THE GULF OF MEXICO

By

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and Stewart Springer

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No. 3. — *New and Little Known Sharks from the Atlantic and from the Gulf of Mexico*[1]

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Experimental trawlings in which we took part, were carried on in the northern sector of the Gulf of Mexico, by "Oregon" of the U. S. Fish and Wildlife Service, 1950–1952, and on the continental slope off southern New England, by the dragger "Cap'n Bill II" chartered by Woods Hole Oceanographic Institution, during the summer of 1952. These have brought to light three sharks of the genera *Etmopterus* and *Scymnodon* which appear to represent species new to science, as do a series, contributed by Dr. Max Poll, of the *Etmopterus* recently reported by him (Poll, 1951) from tropical West Africa, as *E. hillianus*. The "Oregon" and "Cap'n Bill II" trawlings have also yielded specimens of *Apristurus atlanticus*, of *Squalus fernandinus* and of *Centrophorus uyato*, none of which had been recorded previously from the western side of the North Atlantic; also series of *Apristurus profundorum* and of *Scyliorhinus retifer* that add to knowledge of those species.

Myers (1952, p. 108) has recently emphasized the desirability of including a statement of the problem in hand in papers on systematic biology. Thinking the point well taken, we may add that the following pages continue the attempt, on which we have long been engaged, to learn what kinds of elasmobranch fishes exist today, where they live, and how they live.

All the drawings in this paper are by H. B. Bigelow and Jessie H. Sawyer.

Family SCYLIORHINIDAE
Genus Scyliorhinus
Scyliorhinus retifer (Garman) 1881

Previous locality records for positively identified specimens of the chain dogfish had been confined to the outer edge of the continental shelf and upper part of the slope, between the offings of Cape Lookout, North Carolina, and of New York, at depths of 40–125 fathoms (Bigelow and Schroeder, 1948, p. 210). Recent captures by "Oregon" and by the draggers "Eugene H" and "Cap'n Bill II" in 1950, 1951 and 1952 extend the known range of the species to the northern part of the Gulf of Mexico in the one direction and to the offing of southern

[1] Contribution No. 596, Woods Hole Oceanographic Institution.

New England and to the southwestern edge of Georges Bank (Lat. 40°02′N, Long. 69°37′W) in the other. The greatest depth from which *retifer* has yet been recorded in the northern part of its range is 125 fathoms; it ranges deeper, however, in the Gulf of Mexico, where "Oregon" trawled it at 240–260 fathoms.

Genus Apristurus

Examination of a Gulf of Mexico specimen of *Apristurus* apparently referable to *A. atlanticus* Koefoed 1932, known only from off Morocco previously, and of six specimens of *A. profundorum* that were trawled on the continental slope off southern New England by "Cap'n Bill II" during the summer of 1952, enable us to offer a key to the North Atlantic species of the genus, more satisfactory than our earlier attempt (Bigelow and Schroeder, 1948, p. 221).

Key to North Atlantic species of *Apristurus*

1. First to third gill openings nearly as long as distance between inner ends of nostrils; upper and lower labial furrows form about a right angle at each corner of mouth ..... *riveri* Bigelow and Schroeder, 1944
   North coast of Cuba

   First to third gill openings less than half as long as distance between nostrils; upper labial furrow forms an acute angle of about 45° with lower labial furrow at each corner of mouth 2

2. Origin of anal fin under or behind rear end of base of first dorsal; origin of first dorsal fin is above rear part of bases of pelvic fins; base of anal fin only about 2 to 2½ times as long as base of first dorsal fin.....
   profundorum (Goode and Bean) 1895, p. 00

   Origin of anal fin about under origin of first dorsal; origin of first dorsal fin is opposite or behind rear end of bases of pelvic fins; base of anal fin is very nearly 4 times as long as base of first dorsal fin.....
   atlanticus (Koefoed) 1932, p. 00

Apristurus profundorum (Goode and Bean) 1895

Two specimens, only, of this deep water scyliorhinid had been reported previously from the western side of the North Atlantic, both of them taken off Delaware Bay (the type locality) by the "Albatross" many years ago, and both of them in damaged condition when we saw them (Bigelow and Schroeder, 1948, p. 222, Fig. 38). We can now

report eight more, 113 mm. to 596 mm. long, trawled by the dragger "Cap'n Bill II" along the continental slope from southeast of Nova Scotia to southern New England between Lats. 42°39′ and 39°46′N, and between Longs. 63°54′ and 71°35′W, at 395–530 fathoms during June and July, 1952. This additional material allows us to amend our earlier account in the following respects.

A. Relative sizes of first and second dorsal fins: On the type specimen (this was pictured by us earlier) the base of the second dorsal fin is about as long as the base of the first dorsal, with the second dorsal a very little larger in area than the first dorsal. And since the second dorsal is definitely the larger of the pair on a newly hatched specimen, we had regarded this as a juvenile character. But the present series shows that the relative areas of these fins in *profundorum* is subject to considerable variation from specimen to specimen, irrespective of size, the transverse breadths of the first and second dorsals, measured at the rear end of the base, being as follows for six of the "Cap'n Bill II" specimens of different sizes.

total length	*breadth of 1st dorsal*	*breadth of 2nd dorsal*	*ratio of breadth 2nd dorsal to 1st dorsal*
mm.	*mm.*	*mm.*	
596	17.5	18	1.0
514	14.5	17	1.2
267	8	10	1.3
258	7.5	9	1.2
254	7	8	1.1
232	6.5	9	1.4
113	4	4.8	1.2

B. Length of caudal fin: The percentage of the total length that is occupied by the caudal fin is as follows for seven specimens of different sizes: 113 mm., 30%; 146 mm., 25%; 232 mm., 33.6%; 254 mm., 32.3%; 267 mm., 30.7%; 510 mm. (the type[2]) 25%; 514 mm., 25%. Evidently the variation in the relative length of the caudal does not depend on the size of the individual.

C. Lengths of gill openings: The relationship between the length of the third gill opening and the distance between the nostrils is as follows for the specimens listed under *A*.

[2] The 146 mm. specimen, U. S. National Museum, No. 83894, was measured by us earlier; for measurements of the type, of 510 mm., No. 35646, see Bigelow and Schroeder, 1948, p. 222.

total length mm.	*length 3rd gill opening* mm.	*distance between nostrils* mm.	*ratio, distance between nostrils to length of 3rd gill opening*
596	7	22.5	3.2
514	6	21	3.5
267	3.2	10.5	3.3
258	4.5	11	2.4
254	3.5	10.5	3
232	3	11	3.7
113	2	4.5	2.3

The resultant ratios of 2.3 to 3.7 for the gill lengths *vs.* the internarial distance indicate that an appreciable variation exists in these proportions irrespective of the size of the shark.

D. Labial furrows: The upper and lower labial furrows make an angle of about 45° at each corner of the mouth in all of the "Cap'n Bill II" specimens. This is a matter of interest because of the difference in this respect between *A. profundorum* and *A. riveri*, which is employed as an alternative character in the preceding Key to Species (p. 214).

E. Relationship between horizontal diameter of eye and distance between the nostrils:

total length mm.	*diameter of eye* mm.	*distance between nostrils* mm.	*ratio, distance between nostrils to diameter of eye*
596	19.5	23	1.2
514	15	21	1.4
267	7	11	1.6
258	8	11	1.4
254	7	10.5	1.5
232	7	11	1.6
113	5	4	0.8

Thus, there appears to be no trend in the ratio of these proportions as between young and grown specimens although in the new born one (113 mm.) the eye is relatively much larger, as would be expected.

F. Teeth: The number of teeth in the 596 mm. specimen is $\frac{40\text{-}40}{41\text{-}41}$, the outermost in each jaw being difficult to count; this contrasts with $\frac{25\text{-}25}{25\text{-}25}$ recorded for the type specimen, of 510 mm. Both the uppers and the lowers agree closely with our earlier account of those of the type

specimen (Bigelow and Schroeder, 1948, p. 223).

Proportional dimensions in per cent of total length of female, 596 mm. long from Lat. 39°46′N., Long. 71°35′W., 395–405 fathoms, and of male, of 254 mm. long from Lat. 39°52′N., Long. 70°43′W., 415–440 fathoms. Museum of Comparative Zoology Nos. 37425 and 37416, respectively.

Trunk at origin of pectoral: breadth 9.2, 9.5; height 8.4, 8.3.
Snout: length in front of mouth 10.2, 11.8.
Eye: horizontal diameter 3.2, 3.7.
Mouth: breadth 6.9, 5.5.
Nostrils: distance between inner ends 3.8, 4.1.
Labial furrow lengths: upper 3.9, 3.1; lower 2.7, 2.5.
Gill opening lengths: 1st 1.2, 1.2; 3rd 1.2, 1.4; 5th 1.2, 1.4.
First dorsal fin: vertical height 2.8, 2.8; length of base 7.0, 5.9.
Second dorsal fin: vertical height 3.5, 3.3; length of base 6.1, 6.7.
Anal fin: length of base 14.9, 15.0.
Caudal fin: upper margin 25.0, 32.3; lower anterior margin 12.9, 11.8.
Pectoral fin: outer margin 11.9, 11.8; inner margin 5.4, 6.3; width 7.5, 6.3.
Distance from snout to: 1st dorsal 51.2, 44.8; 2nd dorsal 66.2, 57.2; upper caudal 75.0, 67.7; pectoral 22.8, 27.5; pelvics 46.0, 42.9; anal 59.2, 52.7.
Interspace between: 1st and 2nd dorsals 8.0, 6.3; 2nd dorsal and caudal 2.7, 4.0; anal and caudal 0.0, 0.0.
Distance from origin to origin of: pectorals to pelvics 23.1, 15.3; pelvics to anal 13.2, 9.8.

Range. A. profundorum is now known from the continental slope off Delaware Bay (type locality), off southern New England and off the southern part of Georges Bank and the offing of Cape Sable, Nova Scotia at 395–530 fathoms; also off the coast of Iceland, if we are correct in our view that the *Scyllium laurussonii* of Saemundsson (1922, p. 173, Pl. 4, fig. 1) cannot be distinguished from *profundorum*.

Apristurus atlanticus (Koefoed) 1932
Figure 1

This species had been known only from the type specimen 247 mm. long, trawled by the "Michael Sars" off the coast of Morocco, Lat. 28°8′N, Long. 13°35′W from 1365 meters (Koefoed 1932, p. 18,

Pl. 3, fig. 3). We can now report a second specimen, from the northern part of the Gulf of Mexico, which agrees with *atlanticus* in all the features that seem likely to be of specific importance in *Apristurus*. Consequently we refer it to that species, though with some reservation, for Koefoed's original account does not include any information as to shape of nostrils, as to labial furrows, teeth, or dermal denticles; or as to color other than that dark appears to be implied.

Description. Female, 297 mm. long, northern part of Gulf of Mexico, Lat. 27°32′N., Long. 93°02′W., 400–450 fathoms, "Oregon" Station 534, April 11, 1952.

Proportional dimensions in per cent of total length.

Trunk at origin of pectoral: breadth 11.1; height 9.5.

Snout: length in front of mouth 11.5.

Eye: horizontal diameter 3.4.

Mouth: breadth 7.8.

Nostrils: distance between inner ends 4.5.

Labial furrow lengths: upper 2.2; lower 1.9.

Gill opening lengths: 1st 1.2; 3rd 1.2; 5th 1.2.

First dorsal fin: vertical height 2.7; length of base 4.4.

Second dorsal fin: vertical height 3.4; length of base 5.7.

Anal fin: length of base 16.5

Caudal fin: upper margin 28.5; lower anterior margin 11.1.

Pectoral fin: outer margin 11.8; inner margin 6.4; distal margin 10.8.

Distance from snout to: 1st dorsal 51; 2nd dorsal 62; upper caudal 71.5; pectoral 24.6; pelvics 40.5; anal 51.6.

Interspace between: 1st and 2nd dorsals 6.7; 2nd dorsal and caudal 3.7.

Distance from origin to origin of: pectorals to pelvics 16.8; pelvics to anal 10.4.

Trunk, noticeably soft, about ⅛ as high opposite pectorals (where highest) as it is long to origin of caudal fin; somewhat broader there than high, but compressed, thence rearward, so that the caudal peduncle is only about 3/7 as broad as it is high. Dorsal profile sloping gently forward from shoulder region to rather thin-tipped and very flexible snout. Snout ovoid anteriorly, its length to mouth a little less than ½ of head (47%) to origins of pectorals. Eye oval, its horizontal diameter a little less than ⅓ as long as snout in front of mouth (30%). Spiracle between ¼ and ⅕ (22%) as long as eye; close behind eye and about level with the longitudinal axis of eye. Nostrils about 1.4 times

as long as eye, their outer ends at outer edge of head; anterior nasal flap broadly triangular with blunted tip; distance from tip of snout to level of outer (anterior) ends of nostrils about ½ as long as length of snout to mouth; and distance between inner ends of nostrils about 40 per cent as great as length of snout to mouth. Mouth moderately arched, the gape occupying about 70 per cent of breadth of head. Upper labial furrow about ¾ as long as distance between inner ends of nostrils; lower labial furrow about ⅔ as long as upper; the upper and lower labial furrows making an acute angle of about 45° at corner of mouth.

Anterior margins of gill openings concave, but not enough so as to expose the tips of the gill filaments; the longest (4th) about 40 per cent as long as eye, and about 30 per cent as long as distance between nostrils. Teeth $\frac{35\text{-}35}{31\text{-}31}$ in specimens seen; uppers and lowers similar, those along central ⅔ of mouth mostly with 5 or 7 cusps, but those near outer corners of mouth with 3–5 cusps; the median cusp longest and curved slightly outward in most cases, the lateral cusps graduated in length, nearly straight, and radiating outward; about 4 rows of teeth in function simultaneously in each jaw. Dermal denticles minute, clothing the trunk closely and the fins out nearly to margins; the denticles rising steeply from skin over trunk as a whole; leaflike, the blades without evident sculpture, their margins tridentate, those on lower surface of snout with shorter median tooth than those on back, sides, and belly.

First dorsal fin rounded, of shape shown in Figure 1; its base about 1.3 times as long as eye, its origin about 70 per cent of distance rearward from snout toward origin of caudal, and about over origin of anal. Distance from rear end of base of first dorsal to origin of second dorsal about twice as long as eye and about 1½ times as long as base of first dorsal. Second dorsal similar in shape to first; its base about 1.3 times as long as base of first; its length from mid point of base to tip about 1½ times as great as length of first dorsal, similarly measured; its origin about over mid point of base of anal. Distance from rear end of base of second dorsal to origin of caudal a little less than ⅔ (65%) as long as base of second dorsal. Caudal about 1.2 times as long as head to origin of pectorals; upper margin nearly straight; tip rounded — truncate, with moderate subterminal excavation; lower posterior margin slightly sinuous, forming a blunted angle of about 115° with lower anterior margin; the latter being weakly convex.

Anal trapezoid in shape, anterior margin weakly convex; distal margin nearly straight; base nearly three times (2.9) as long as base of second dorsal; origin about under origin of first dorsal. No measurable interspace between rear end of base of anal and origin of lower side of caudal fin. Pelvics rhomboid; the margins nearly straight, the corners rounded; outer margin about 2½ times as long as anterior margin; base about 60 per cent as long as base of anal; interspace between rear end of base of pelvics and origin of anal about ⅕ as long as base of anal. Distance between origin of pelvics and axils of pectorals about 1.1 times as long as base of pelvics (in female). Pectorals with broadly rounded corners and weakly convex margins, of shape shown in Figure 1. Extreme length of pectoral from point of origin, about as great as distance from front of eye to pelvic origin; the fin conspicuously broad based, the base being about as long as maximum breadth of pectoral fin.

Color. The "Oregon" specimen is uniformly dark sooty gray, after preservation in alcohol, both on trunk and on fins out to their margins, and about as dark below as above. The type specimen is described as "brown" (Koefoed, 1932, p. 19).

Size. The two specimens that have been seen are respectively 247 mm. (the type) and 297 mm. ("Oregon" specimen) long; but as both are females their sizes give no clue to how large this shark may grow.

Remarks. A. atlanticus resembles *A. profundorum* very closely in its general appearance. But the differences between the two listed in the preceding key (p. 214) are so sharp-cut that identification of any given specimen of *Apristurus* of this general type as the one species or as the other should present no special difficulty.

Range. Present indications are that *atlanticus* is restricted to the tropical-subtropical belt of the Atlantic, east and west, including the Gulf of Mexico, localities of record for it being off the coast of Morocco[3], and the northern part of the Gulf of Mexico at the locality listed above, (p. 218) at depths of 746 fathoms and 400–450 fathoms respectively. Nothing is known about its habits.

Family SQUALIDAE

Genus SQUALUS

SQUALUS FERNANDINUS Molina 1782

Figure 2

The only members of this well known genus that have been reported

[3] "Michael Sars" N. Atlant. Exped. 1910, Sta. 41.

reliably from the western side of the Atlantic, north of the equator, or from the Gulf of Mexico, are the common spiny dog (*Squalus acanthias* Linnaeus 1758) of northern seas, and the Cuban dog (*Squalus cubensis* Howell-Rivero 1936). But word was to be expected, sooner or later, of spiny dogfishes of the *fernandinus-blainville* group somewhere along our South Atlantic coasts, or in the Gulf of Mexico, for these little sharks are common not only in the Mediterranean but along tropical West Africa as well.[4] And we can now report the captures of two small specimens of this group off South Carolina (Lat. 33°00′N, Long. 77°07′W), by "Albatross" III of the U. S. Fish and Wildlife Service, in a trawl haul from 206 fathoms, and of a third (a female of 640 mm.) trawled by "Oregon" in the northern part of the Gulf of Mexico, Lat. 27°44′N, Long. 85°02′W, at 215 fathoms, September 29, 1951; "Oregon" Sta. 490.

Comparison has failed to show anything to differentiate these specimens, as to species, from an excellent female of *fernandinus*, of 914 mm., in the Museum of Comparative Zoology, from the island of Juan Fernandez, which is the type locality of the species.[5] The only other reliable record for a shark of the *fernandinus-blainville* group, for the western side of the Atlantic, north or south, is for a 320 mm. specimen that was taken from the stomach of an albatross off the coast of Argentina, Lat. 34°44′S, Long. 53°W (Lahille, 1928, p. 327; Bigelow and Schroeder, 1948, p. 479, Footnote 65).

Among the North Atlantic members of its genus, *fernandinus* differs from *acanthias* in that the exposed base of its first dorsal fin spine stands about even with the inner corner of the pectoral or a little anterior to it, when the fin is laid back (considerably posterior to the inner corner of the pectoral in *acanthias*); that the mid points of the bases of the pelvics are about opposite the mid point of the interspace between the two dorsals (Fig. 2; much nearer the second dorsal than the first dorsal in *acanthias*); and that the flap-like expansion of the anterior (inner) margin of the nostril bears a small accessory lobe. *Fernandinus* agrees with *cubensis* in the foregoing respects. But there should be no danger of confusing the one species with the other, for the distal margin of the pectoral is only weakly concave in *fernandinus*, and the inner corner of the fin rounded, whereas the distal pectoral

[4] Poll (1951, p. 59) reports *fernandinus* at 19 stations along the West African coast between latitudes 9°32′N, and 19°52′S.

[5] For an illustration of this Juan Fernandez specimen, see Bigelow and Schroeder, 1948, p. 456, Fig. 87E.

margin is deeply concave and the inner pectoral corner sharp-pointed in *cubensis*.

In our earlier discussion of the species of the genus *Squalus* (Bigelow and Schroeder, 1948, p. 454, 455) we retained *blainville* Risso 1826 of the Mediterranean provisionally, as distinct from *fernandinus*, because perhaps it has a relatively longer second dorsal spine than that of *fernandinus*, and a larger eye relative to the length of the snout and relative to the distance between the nostrils. But it appears that the second dorsal spine may vary considerably in length in the Mediterranean form, for while Rey (1928, p. 43) writes that it may exceed the length of the anterior margin of the fin in *blainville*, his excellent illustration of the latter (Rey, 1928, Pl. 4, Fig. 2), which we had overlooked, pictures its tip as falling about as far short of the apex of the fin as is the case in our Gulf of Mexico specimen of *fernandinus*, and almost as far short of the apex of the fin as in the Juan Fernandez specimen.[6] Neither does it seem likely that the size of the eye relative to the length of the snout in front of the mouth (horizontal diameter of eye about 60 per cent as long as snout in *blainville*, *vs.* 40–50 per cent in *fernandinus*[7]) can be used as the basis of specific separation. Poll's (1951, p. 59) definite reference of *blainville* to the synonymy of *fernandinus* seems, therefore, to be correct.

Squalus cubensis Howell-Rivero 1936

The Cuban dogfish, made easily recognizable among North Atlantic spiny dogs of the genus *Squalus* by the sharply pointed inner corner of its pectoral fin, was known only from the north coast of Cuba, from Trinidad (probably), and from Rio de Janeiro (Bigelow and Schroeder, 1948, p. 477). We can now report it from the northern part of the Gulf of Mexico, when "Oregon" trawled two specimens, 375 and 465 mm. long, one at Station 257, Lat. 28°41′N, Long. 86°03′W, on January 27, 1951, 165 fathoms; the other at Station 278, Lat. 29°49′N, Long. 85°45′W, 112 fathoms on February 24, 1951. The geographic distribution of the locality records for this species suggests that it will prove to be widespread throughout the West Indian, Gulf, and Caribbean regions, and along the northern and northeastern coasts of South America.

[6] In the Juan Fernandez specimen the spine, measured from the level at which it emerges from the skin, is about 77 per cent as long as the free anterior margin of the fin. Our earlier illustration (Bigelow and Schroeder, 1948, Fig. 87E) pictures it as too short.

[7] In our Western Atlantic and Gulf of Mexico specimens, the varietal range in this respect is from 40 to 50 per cent. In the Juan Fernandez specimen it is 48 per cent, stated erroneously as 40 per cent in alternative 3B of our earlier key to the Western Atlantic species of *Squalus*. (Bigelow and Schroeder, 1948, p. 455.)

Genus CENTROPHORUS Müller & Henle 1837

The genus *Centrophorus* was proposed by Müller and Henle (1837, p. 398) for a squalid shark identified by them as the *Squalus granulosus* of Bloch and Schneider 1801, of which Müller and Henle published a detailed account with illustrations four years later (1841, p. 88, Pl. 33), based in part on a dried specimen from Bloch's collection, as well as on other specimens from Sicily. Its most distinctive characters, among squalid sharks, are: upper and lower teeth both one-cusped, but unlike in the two jaws, the cusps of the lowers being blade-like and directed sharply outward along each half of the jaw, the cusps of the uppers more narrowly triangular to awl shaped along the median section of the jaw, but more nearly similar to the lowers toward each corner of the mouth; dorsal fin spines lying along anterior margins of the fins, the second longer than the first, and both of them at least moderately prominent; both the dorsal fins short, neither member of the pair much larger than the other; pectoral fins with the inner corner sharp pointed and considerably extended. And the passage of time has added nothing to make us doubt the validity of the foregoing set of characters as distinctive of the genus *Centrophorus*. Garman (1913, pp. 189, 211), it is true, abandoning the shape of the pectorals as a primary generic character, retained the genus *Lepidorhinus* Bonaparte 1838, not only for the reception of its type species, *Squalus squamosus* Bonnaterre 1788, but also for *Centrophorus steindachneri* Pietschmann 1907,[8] both of which fall in *Centrophorus* as defined here because the pectoral corners of each are sharp pointed though only slightly extended. Garman also placed *Centrophorus foliaceus* Günther 1877 and *Centrophorus rossi* Alcock 1898 in *Lepidorhinus* but both of these fall in the genus *Scymnodon* in our view, because with rounded inner pectoral corners (p. 230). But to abandon the shape of the pectorals as a primary generic character is to ignore the most conspicuous feature by which we can subdivide the considerable group of squaloids that agree in having one-cusped blade like teeth in both jaws and simple, dermal denticles.

The species in question with the inner corners of the pectorals more or less produced, have been redistributed more recently by Fowler (1941, p. 229, 242) between *Centrophorus* Müller and Henle 1837, and *Entoxychirus* Gill 1862. But, as we have already remarked (1948, p. 451, footnote 8), "the differences on which this division is based, i.e., the relative degrees to which the inner corners of the pectorals

[8] For a good illustration of *steindachneri*, see Pietschmann, 1908, Pl. 1, fig. 1.

are produced and the shapes of the dermal denticles, do not seem to us sufficient for generic separation."

Sharks, referable to *Centrophorus* as defined here, that have been named from the North Atlantic and Mediterranean, are *Squalus squamosus* Bonnaterre 1788; *S. granulosus* Bloch and Schneider 1801 (discussed above); *Galeus* [*Squalus*] *uyato* Rafinesque 1810; *Centrophorus lusitanicus* Bocage and Capello 1864; *Machephilus dumerilii* Johnson 1867; and *Centrophorus braganzae* Regan 1906. The *Squalus infernus* of Blainville 1825 was also placed in *Centrophorus* by Garman (1913, p. 197), as a synonym of *uyato*, perhaps on the strength of Blainville's (1825, p. 60) suggestion that it might be identical with Rafinesque's *uyato*. But Blainville's (1825, p. 59) description of its upper teeth as with a rather long erect, pointed median cusp flanked on either side by a small accessory cusp, combined with his failure to mention the shape of the inner corners of the pectorals, suggest that *infernus* was not a *Centrophorus*.[9] Its tooth characters, as described by Blainville, suggest, rather, an *Etmopterus* (p. 237) , but the proportional dimensions given for it by him differ considerably from those of any member of that genus known from the Atlantic.

Garman (1913, pp. 197, 212) was no doubt correct in referring *braganzae* to the synonymy of *uyato*, and *dumerilii* to that of *squamosus*. Rey (1928, p. 436) has reduced the list of accepted species still farther by placing both *lusitanicus* and *uyato* in the synonymy of *granulosus*. And while Nobre (1935, p. 449)[10] has revived *lusitanicus* as a distinct species, Rey's treatment of it seems to be preferable, so far as we can judge from Bocage and Capello's (1864, p. 260, fig. 1) original description and illustration of it. *C. squamosus* (Bonnaterre) 1788, differs both from *granulosus* and from *uyato* in the shape of its pectoral fins, in a relatively larger second dorsal fin relative to the first dorsal, and also in its dermal denticles (see below).

The status of *uyato*, if perhaps more puzzling, is the most pertinent to our present study. The original account and illustration of it, by Rafinesque (1810, p. 13, Pl. 14, fig. 2) tell us only that it resembles *Squalus* in general, but has minute, sharp teeth, and that the inner corners of the pectorals are somewhat extended, and angular. About all we learn from the brief first-hand accounts that have appeared since Rafinesque's time is that the eastern Atlantic in low and mid latitudes and the Mediterranean do harbor a *Centrophorus*, to which

[9] We might note, in passing, that while Blainville (1825, p. 59) quotes "Pl. 14, Fig. 1" for his *infernus*, his Pl.14 actually pictures a Thresher (Fig. 1) and a *Lamna* (Fig. 2).

[10] His Plate 61, figure 194, is credited both to *granulosus* (p. 448) and to *lusitanicus* (p. 449).

the name *uyato* Rafinesque 1810 seems to apply. It appears to differ from *C. granulosus* (Bloch and Schneider) 1801, type species of the genus, in its sharp, pointed, dermal denticles and in a longer second dorsal spine; perhaps in some of its proportional dimensions as well, though such information as is available does not afford satisfactory comparison between the two in this last respect.[11] Comparison, however, of the specimens of *uyato* described below, with a dried skin of *granulosus*, about 860 mm. long, from Europe (no definite locality), in the Museum of Comparative Zoology, shows that the two species actually differ widely as regards their dermal denticles, those of *granulosus* being block-like, quadrate, and close set in quincunx mosaic (Fig. 3A), but those of *uyato* very small, conical, thorn like, recurved, and so sparsely distributed that the skin is exposed between them (Fig. 3C). And the denticles of *C. squamosus* (Fig. 3B) are of so different a type, being scale like and overlapping, that a glance at the skin with a hand lens is sufficient for identification, among these three species (Fig. 3).

Provisional Key to North Atlantic-Mediterranean Species of *Centrophorus*

1. Inner corners of pectorals only a little extended though sharp-pointed, reaching only about even with origin of first dorsal fin when pectoral is laid back; base of first dorsal fin nearly or fully twice as long as base of second dorsal. Dermal denticles scale-like, overlapping (Fig. 3B). . . . . *squamosus* (Bonnaterre) 1788[12]

   Inner corners of pectorals considerably extended, reaching nearly or quite as far as the mid base of the first dorsal when the pectoral is laid back; base of first dorsal fin only about 1⅓-1½ times as long as base of second dorsal; dermal denticles not overlapping. 2

2. Cutting edges of cusps of lower teeth with fine serrations more or less evident[13]; second dorsal spine reaches not more than ½ way along free anterior margin of second dorsal fin; dermal denticles block-like, sessile from end to end, the exposed surface nearly parallel with the skin so that

[11]Poll's (1951, p. 60, fig. 33; p. 65, fig. 34) recent illustrations of *uyato* in side view, and of the lower surface of its head, are not accompanied by a description.

[12]For excellent illustrations of *squamosus*, see Jensen, 1899, Pl. 3; and Saemundsson, 1932, Pl. not numbered (*Centrophorus squamosus*). The Museum of Comparative Zoology has recently received an excellent specimen of *squamosus* about 49 inches long from west of Iceland, 218 fathoms, from Dr. Arni Fridricksson.

[13]Described and pictured as finely serrate by Müller and Henle (1841, p. 88, Pl. 33); also by Bocage and Capello (1866, p. 26, Pl. 1, Fig. 3D); and so described by Garman (1913, p. 202). But microscopic examination of the teeth of the specimen Garman had at hand shows no regular serrations but only a certain amount of raggedness.

the latter feels no rougher when stroked from rear to front than when stroked from front to rear; and so close spaced in regular quincuncial mosaic that they are very nearly in contact, one with the next, concealing the skin; the exposed surface nearly square in outer view, with rounded edges and angles, cornering antero-posteriorly, and weakly convex dorso-ventrally, the anterior ½ to ⅔ sculptured radially with 5 to 7 low ridges separated by shallow rounded furrows, converging anteriorly, so that two adjacent ridges often fuse one with the other (Fig. 3A); lining of mouth dark-spotted, only..... *granulosus* (Bloch and Schneider) 1801

Cutting edges of lower teeth perfectly smooth; second dorsal spine reaching at least ⅔ the way along free anterior margin of second dorsal fin; dermal denticles (Fig. 3C) conical-thorn shaped, sharp-pointed, so loosely spaced that the skin is widely exposed between them, and with the tips elevated so that the skin is much rougher to the touch when stroked from rear to front than when stroked from front to rear; the outer surface sculptured with 3 to 5 sharp radial ridges converging toward the tip; lining of mouth uniformly either sooty gray, very dark blue, or perhaps black..... ..... *uyato* (Rafinesque) 1810, p. 227

Besides the North Atlantic species just discussed, nine of the squalid sharks that have been named from Indo-Pacific waters fall in the genus *Centrophorus* as defined here; namely, *C. tesselatus* Garman 1906, *C. steindachneri* Pietschmann 1907, *C. acus* Garman 1913 and *C. atromarginatus* Garman 1913 from Japanese waters; *C. moluccensis* Bleeker 1860 from the East Indies; *C. nilsoni* Thompson 1930 from New Zealand; *C. scalpratus* McCulloch 1915 and *C. harrisonii* McCulloch 1915 from Victoria, Australia; and *Atractophorus armatus* Gilchrist 1922 from southern Africa.[14] These stand in evident need of revision which we are now not able to undertake.

Up to the present time, records for the genus *Centrophorus* in the Atlantic had been from the eastern side only; those for *granulosus* from the Canaries, Madeira, Spain (both coasts) and Portugal; those for *uyato* from Senegal and the Mediterranean; those for *squamosus* from Madeira, the Azores, the Mediterranean, Portugal, the waters southwest of Ireland, the Faroe Bank, and south and southwest of

[14] Fowler (1941, p. 233, 234) also includes *Centrophorus kaikurae* Whitley, 1934, and *Centrophorus waitei* Thompson 1930 in the genus *Centrophorus*. But the illustrations of the former by Thompson (1930, Pl. 42, Figs. a–i, as *C. calceus* Lowe 1839), show it as with rounded pectoral inner corners, and with a very long first dorsal fin, long pointed snout, and pitchfork shaped dermal denticles; these refer it to the genus *Deania* according to the classification adopted earlier by us. And *waitei* seems referable provisionally to *Scymnodon*, though Thompson's illustration of it (1930, Pl. 44, Fig. A) seems to have been of a specimen with damaged fins, the caudal being pictured as with a pointed tip, and the pectoral as paddle shaped, bilaterally symmetrical, broadest about midway of its length and tapering to a narrowly rounded tip, which does not accord with any known group of squalids.

Iceland.

The known range of the genus has now been extended to the northern part of the Gulf of Mexico, by the capture there of three specimens which appear to be specifically identical with the specimen in the Museum of Comparative Zoology from "France" on which Garman (1913, p. 197, as *uyatus*) based his description of *uyato*. As this is the first report of the presence of the genus *Centrophorus* in the western side of the Atlantic, a description follows from which the reader may judge the correctness of our identification.

CENTROPHORUS UYATO (Rafinesque) 1810

Figure 4

Study material. Female, 420 mm. long, "Oregon" Sta. 278, Lat. 28°39′N, Long. 85°46′W, 112 fathoms, February 24, 1951; juvenile male, about 429 mm., and female about 442 mm., "Oregon" Sta. 515, Lat. 29°17′N, Long. 87°42′W, 208 fathoms, April 1, 1952. Also juvenile male, 480 mm., Nice, France, in Museum of Comparative Zoology.

Description. Proportional dimensions, in per cent of total length, of female, 442 mm., Gulf of Mexico; and juvenile male, 480 mm., Nice, France (Mus. Comp. Zool. No. 943).

Trunk at origin of pectoral: breadth 10.8, 9.9; height 11.3, 11.4.

Snout: length in front of mouth 11.8, 10.5.

Eye: horizontal diameter 5.6, 5.9.

Mouth: breadth 7.5, 7.3.

Nostrils: distance between inner ends 4.1, 3.8.

Labial furrow: 5.6, 5.1.

Gill opening lengths: 1st 2.5, 2.1; 4th 2.9, 2.7; 5th 3.1, 3.1.

First dorsal fin: vertical height 6.3, 6.9; length of base[15] 7.7, 8.2.

Second dorsal fin: vertical height 4.9, 4.6; length of base[15] 6.5, 5.7.

Caudal fin: upper margin 23, 22.8; lower anterior margin 13.3, 13.2.

Pectoral fin: outer margin 12.0, 12.0; inner margin 13.5, 12.6; distal margin 11.8, 11.1.

Distance from snout to: 1st dorsal[15] 32.8, 34.2; 2nd dorsal[15] 62.8, 66.2; upper caudal 77.0, 77.2; pectoral 22.8, 22.7; pelvics 53.5, 56.1.

Interspace between: 1st and 2nd[15] dorsals 21.2, 25.8; 2nd dorsal and caudal 6.8, 7.1; rear base of pelvics and caudal 14.0, 14.0.

Distance from origin to origin of: pectorals to pelvics 30.7, 33.4; pelvics to caudal 19.4, 20.6.

[15] to base of spine.

Trunk fusiform, tapering both rearward and forward from region of first dorsal fin; ovoid in cross section, the belly somewhat flattened (unless in gravid females or after a full meal); caudal peduncle without lateral longitudinal ridges. Height at first dorsal (where highest) about 1/5 as great as length to origin of caudal; the breadth there about 1/2 as great as the height or a little more; breadth close in front of first gill openings (where broadest) a little more than 1 1/2 times as great (1.7 times in 442 mm. female) as at level of first dorsal fin. Head nearly straight in dorsal profile, its length to origin of pectorals nearly 1/3 (30% in 442 mm. female) of trunk to origin of caudal fin. Snout thin tipped, narrowing forward to rounded tip (Fig. 4); its length in front of mouth a little less than 1/2 of head (47% in 442 mm. female) to origin of pectorals. Eyes noticeably large, a little more than twice as long as high, and about 1/4 as long as head. Distance from front of eye to tip of snout about 1.2 times as long as eye. Spiracles about 1/3 as long as eye, posterior to latter by a distance about 1/5 as long as eye, and at a slightly higher level than longitudinal axis of eye.

Nostrils about 1/4 as long as eye; nearly transverse; their outer (anterior) ends posterior to tip of snout by a distance about 4/5 as long as eye; anterior nasal flap rather broadly triangular with rounded tip; and without accessory lobe. Mouth very low-arched, the gape (when closed) occupying about 2/3 of breadth of head or a little more; labial furrows noticeably short, the upper furrows extending inward a little less than half of distance toward the mid line of head; the lower furrows a little shorter; their rearward extensions traceable about half the distance toward the first gill openings. Anterior margins of first to fourth gill openings weakly concave, the fifth the most oblique; longest gill (fifth) about 1.2 times as long as first, and a little more than 1/2 (52–55%) as long as horizontal diameter of eye. Teeth $\frac{18\text{-}1\text{-}19}{16\text{-}1\text{-}16}$ in female of 442 mm. one-cusped and smooth edged; uppers with triangular cusp on quadrate base; the median upper tooth erect and symmetrical, the next few teeth either side of the symphysis nearly so, but successive teeth thence outward along each side of the jaw with cusps increasingly oblique, so that the upper teeth along the outer 1/4 or so of the jaw are similar to the lowers in shape. Lower teeth (except for median tooth) considerably larger than uppers, the cusps triangular, directed strongly outward all along each half of the jaw, their inner cutting margins at an angle of about 15° with the general contour of jaw. Lower median tooth much smaller than the others, its

cusp curving obliquely toward the one side or the other. Teeth $\frac{18\text{-}18}{16\text{-}16}$ in male of 480 mm., no median tooth.[16] Dermal denticles small (average length about 0.2 mm. on 442 mm. specimen), evenly distributed in random arrangement, mostly spaced so loosely that skin is widely exposed between them, but rarely the tip of one overlapping the base of the next; the denticles clothing entire trunk and fins out to margins; anterior ends of denticles thick, sessile, but tips elevated so that skin is rough to the touch; blades thick, ovoid narrowing rearward to sharp pointed tip; their upper surface conspicuously corrugated with median ridge flanked either side by two (usually) lateral ridges, the furrows converging toward tip, and the extreme margin also elevated a little. Denticles on lower surface in general similar to those on sides and back, but those on fins smaller, narrower, very sharp tipped, and less conspicuously sculptured, or even smooth.

Origin of first dorsal (first sensible elevation above general profile of back) posterior to origins of pectorals by a distance about as long as from tip of snout to center of eye; its base about twice as long as distance between nostrils, or about 1.2 times as long as from tip of snout to eye; anterior margin weakly convex, distal margin moderately concave, rear tip rather narrowly acuminate, free lower margin about as long as from rear end of base to point of emergence of spine. Interspace from rear end of base of first dorsal to origin of second dorsal (first sensible elevation) about as long as from snout to level of second gill opening. Second dorsal similar to first in shape, but only about $\frac{3}{4}$ as long as first dorsal at base and correspondingly smaller in area. Dorsal fin spines with a longitudinal groove close to anterior edge on either side; the rear surface of the spines slightly furrowed also. Both of the spines are well exposed; the second about $1\frac{1}{3}$ times as long as the first, its tip about even with the apex of the fin. Interspace between rear end of base of second dorsal and origin of upper side of caudal a little longer than base of second dorsal. Caudal fin about as long as head to origin of pectorals; about $\frac{1}{2}$ as broad as long or a little less, the upper margin nearly straight, tip obliquely truncate; lower posterior margin with obtuse subterminal excavation, the lower anterior corner a little extended as a low, rounded lobe; the lower anterior margin weakly convex, about 3/5 (58–60%) as long as upper margin. Interspace between lower origin of caudal and rear ends of bases of pelvics about as long as distance from snout to level of spiracles

[16] For a recent account of the spacial relationships between the successive rows of teeth in *C. uyato*, see Landholt, 1947, p. 353

or slightly more than ½ (54%) as long as from origins of pelvics to axils of pectorals. Pelvics approximately as large as second dorsal, their origin at a perpendicular about ½ to ⅔ of the distance rearward from rear end of first dorsal base toward origin of second dorsal. Anterior pelvic margin moderately convex, outer corner rounded, distal and inner margins weakly concave, rear corner pointed, reaching back about to below second dorsal fin spine. Pectorals with moderately convex outer margin, rounded outer corner, the distal margin nearly straight outwardly, but inwardly curving rearward to narrowly acuminate, sharp pointed inner-rear corner; the latter reaching back nearly or quite as far as rear end of base of first dorsal when pectoral is laid back; inner pectoral margin thus about as long as from tip of snout to rear of eye.

Color. Back and upper parts of the sides mouse gray after preservation in alcohol, paling to greyish white along the lower parts of the sides and on the lower surface as a whole; outer parts of the dorsal and caudal fins in general are sooty, but rear tips of dorsals, also extreme distal margin and acuminate rear corner of pectorals pale; a pale spot at base of each dorsal fin spine also; and one on the top of the head between the eyes. Region of gill openings bluish (perhaps brighter blue in life); lining of mouth uniformly very dark gray blue;[17] lining of body cavity black.

Size. This shark has been reported up to about 38½ inches (980 mm.) long (Poll 1951, p. 64). How much larger it may grow is not known.

Genus SCYMNODON Bocage and Capello 1864

Sharks of this genus are characterized among the Squalidae by dorsal fin spines at the anterior edges of the fins with at least the tips projecting; by one-cusped teeth above as well as below, the uppers much narrower than the lowers, at least along the central part of the mouth; by more or less acutely dentate dermal denticles; and by rounded inner pectoral corners. Their closest affinities seem to be with *Centrophorus* from which they differ chiefly in the shape of the pectoral fins, and with *Centroscymnus*, from which they are separated by their dentate dermal dentieles.[18] In the type species of the genus,

[17]The linings of the mouth and of the body cavity are described as dark turquoise by Bonaparte (1841, text to Pl. 57).

[18]The distinction between *Scymnodon* and *Centroscymnus* applies only to adults, if Tortonese's (1952, p. 386, fig. 1) recent identification of a juvenile male with dentate denticles is correct, as *C. coelolepis*.

ringens Bocage and Capello (1864, p. 261, fig. 5 p. 263; 1866, p. 32, Pl. 1, fig. 1), the broadly triangular cusps of the lower teeth are described as symmetrical and erect along the central part of the jaw, but as directed increasingly outward, toward its corners;[19] and the genus *Scymnodon* was characterized accordingly in Bocage and Capello's original (1864) diagnosis.[20] But the genus has been expanded, by subsequent authors,[21] to include species in which the lower teeth are more or less strongly oblique all along the jaw, from the symphysis to either corner of the mouth.

Three species referable to *Scymnodon* as defined above are known from the eastern side of the North Atlantic, *ringens* Bocage and Capello 1864,[22] *crepidator* (Bocage and Capello) 1864,[23] and *jonsonii* Saemundsson (1922).[24] Fowler (1941, pp. 226, 227) credits a third species, *Scymnodon squamulosus* (Günther) 1877, to the Atlantic, quoting Regan (1908, p. 48) as authority. But the locality stated for *squamulosus* by Regan was Japan, nor has it ever been reported elsewhere, so far as we know.

Available information, including notes on a specimen in the British Museum, identified by Günther as *crepidator*, kindly contributed by Mr. N. B. Marshall, also makes it likely that the cusps are erect (or nearly so) on a larger number of the teeth along the mid section of the lower jaw in *ringens*, and the dermal denticles more pronouncedly tridentate, than in *crepidator*, though a more detailed comparison between the two species is much to be desired in these respects. If the illustrations of the two that have appeared are to be relied upon, *crepidator* differs further from *ringens* in smaller eyes, but a considerably longer snout relative to other bodily proportions.[25] The illustrations suggest also that the caudal is truncate at the tip, and with a

[19]For the best description and illustration of the teeth of *S. ringens* with which we are acquainted, see Rey, 1928, pp. 455, 456, fig. 152.

[20]In their subsequent account (1866, p. 32, Pl. 1, fig. 1C) they characterized the lower teeth as erect, and so pictured them all around the jaw.

[21]Garman 1913, pp. 207–208; Fowler 1941, pp. 225–226; Bigelow and Schroeder 1948, pp. 450–451.

[22]For descriptions and illustrations see Bocage and Capello 1866, p. 31, Pl. 1, fig. 1; and Rey 1928, p. 454.

[23]For descriptions and illustrations see Bocage and Capello 1866, p. 27, Pl. 2, fig. 2; and Rey 1928, p. 449. *Crepidator*, referred by its describers to the genus *Centrophorus*, was made the type of a new genus *Centroselachus* by Garman 1913, p. 206. But it falls within the limits of *Scymnodon* as defined here. See Bigelow and Schroeder 1948, p. 494, footnote 1.

[24]For description and illustrations see Saemundsson 1922, p. 192, Pl. 5, figs. 1, 2. According to Saemundsson, the first mention of this species was in Schmidt, 1901, p. 23, where it was listed as "*Centrophorus* nov. spec." on the authority of Jensen.

[25]Eye about $\frac{1}{5}$ to $\frac{1}{4}$ and snout about $\frac{1}{5}$ to $\frac{1}{4}$ of head in *ringens;* eye about $\frac{1}{8}$ and snout about $\frac{1}{3}$ of head in *crepidator.*

definite lower anterior lobe in *crepidator*, contrasting with narrowly rounded tip, and without lower anterior lobe as it is described[26] and pictured[27] in *ringens*. But it is a question whether the pictured differences can be accepted as specific, for the tracing by Mr. Marshall of the caudal of the British Museum specimen labelled *crepidator* shows the fin as intermediate in shape in these respects, i.e. with rounded tip, but with definite lower anterior lobe. In both *ringens* and in *crepidator* the upper tooth band along each side of the upper jaw follows an arc of long radius, the convexity directed rearward, with these two lateral arcs connected by a shorter but similar arc in the region of the symphysis. And in both of them the entire pelvic fin on each side is anterior to a perpendicular at the point of emergence of the second dorsal fin spine. *Jonsonii*[28] differs conspicuously both from *ringens* and from *crepidator* in that its pelvic fins are described and pictured as with their bases very nearly opposite the base of the second dorsal fin.[29]

The following seven squalids also, that have been named from the Pacific and Indian Oceans, and from the Straits of Magellan, appear to fall in the genus *Scymnodon* as defined here: *foliaceous* (Günther) 1877, Japan and also reported from the Philippines;[30] *macracanthus* (Regan) 1906, Straits of Magellan; *plunketi* (Waite) 1910, New Zealand; *rossi* (Alcock) 1898, India; *sherwoodi* Archey 1921, New Zealand; *squamulosus* (Günther) 1877, Japan; and *waitei* (Thompson) 1910, New Zealand. *Macracanthus* is set apart, among these, by "well developed and strongly projecting" first and second fin-spines;[31] *foliaceous* by a strongly projecting second dorsal fin-spine.[32] If the original illustration is to be relied upon, *waitei* is even more sharply separated from its genus mates by a pointed caudal fin. The remaining members of the Pacific-Indian Ocean group (*rossi*, *plunketi*, *sherwoodi* and *squamulosus*) resemble one another closely in most respects. But *squamulosus* is the only one of these that we have seen, and the published accounts of the other three are not detailed enough to serve as basis for the revision of which they stand in evident need.

[26]Bocage and Capello 1866, p. 39, footnote.

[27]Bocage and Capello 1866, Pl. 1, fig. 1; Rey 1928, p. 455, Fig. 151.

[28]Saemundsson (1922, p. 192, Pl. 5, figs. 1, 2), who has given the only detailed account of this species, left it in the genus *Centrophorus*. But his description of its pectoral fin as with rounded posterior corner places it in *Scymnodon* according to the scheme followed here.

[29]Saemundsson 1922, p. 195 (Table of Measurements), Pl. 5, fig. 1.

[30]By Smith and Radcliffe 1912, p. 679.

[31]Regan 1906, p. 436.

[32]As pictured and described by its author. Jordan and Fowler's (1903, p. 631) description as *foliaceus*, of a Japanese specimen with only the tips of the fin spines exposed suggests that they may have been dealing with *squamulosus*, in which this is the case.

The experimental trawlings by "Cap'n Bill II" on the continental slope off southern New England and off Georges Bank during the summer of 1952 have now yielded three specimens of a *Scymnodon* which seem not to be referable either to *ringens* or to *crepidator* for the reasons stated below (p. 236), and which differ from *jonsonii* in the fact that their pelvic fins are wholly anterior to the base of the second dorsal fin (for further discussion, see p. 232). Neither do the specimens in question seem to fall within the probable limits of variation of any of the representatives of the genus that have been described from other seas. We therefore propose for it the new specific name *melas*. We must confess, however, that we would do so with more confidence, if the published accounts and illustrations of *ringens* and of *crepidator* were more satisfactory and informative.

Scymnodon melas, n. sp.
Figure 5

Type specimen. Female, 462 mm. long, trawled by the dragger "Cap'n Bill II" on the continental slope off Georges Bank, Lat. 40°00′N, Long. 68°52′W, at 420–480 fathoms, July 12, 1952, Museum of Comparative Zoology, No. 37452.

Additional material. Two juvenile males, 330 mm. and 339 mm. long, trawled by "Cap'n Bill II" on the slope off southern New England, Lat. 39°52′N, Long. 70°43′W, 415–440 fathoms, and Lat. 39°51′N, Long. 70°48′W, 450–495 fathoms, both on August 24, 1952, also in Museum of Comparative Zoology.

Description. Proportional dimensions, in per cent of total length, of female of 462 mm. (type) and male, 339 mm.

Trunk at origin of pectoral: breadth 13.2, 12.1.

Snout: length in front of mouth 8.2, 9.8.

Eye: horizontal diameter 4.1, 4.1.

Mouth: breadth 7.8, 7.7.

Nostrils: distance between inner ends 3.9, 3.5.

Labial furrow length from corner of mouth: 7.3, 7.4.

Gill opening lengths: 1st 1.3, 1.3; 2nd 1.3, 1.3; 3rd 1.3, 1.3; 4th 1.3, 1.3; 5th 1.6, 1.6.

First dorsal fin: vertical height 3.0, 3.2; length of base 5.0, 4.7.

Second dorsal fin: vertical height 3.2, 3.5; length of base 6.1, 4.7.

Caudal fin: upper margin 23, 22.

Pectoral fin: extreme length 12.3, 12.1.

Distance from snout to: 1st gill opening 17.9, 19.2; 1st dorsal origin

35.5, 34.2; 2nd dorsal origin 62.8, 64; upper caudal origin 77, 78; pectoral origin 22.5, 23.3; pelvic origins 59.8, 59.3.

Interspace between: 1st and 2nd dorsals 22.3, 25.1; 2nd dorsal and caudal 8.2, 9.2; base of pelvics and caudal 10.4, 9.7.

Distance from origin to origin of: pectorals to pelvics 37.2, 36.1; pelvics to caudal 10.8, 10.9.

Trunk at first dorsal (where highest) about 1/6 as high as it is long to origin of caudal; slightly flattened sidewise, rearward from pectoral fins; its thickness at first dorsal only about ½ as great as its height there, but much thicker anteriorly, the breadth of the head, abreast of the first gill opening being almost twice as great as that of the body at the first dorsal. Head, to origin of pectorals, between ¼ and ⅓ (29%) of length of trunk to origin of caudal; flattened above, the dorsal profile sloping downward slightly; only a little narrowed at eyes. Snout moderately fleshy, but not very flexible; its anterior outline obtusely angular with rounded tip; its length in front of mouth 37 per cent of head, and its length to eyes 19 per cent. Eye oval, a little more than twice as long as high, its horizontal diameter ½ as long as snout in front of mouth. Spiracle about ⅓ as long as eye, its outward margin about on a level with upper margin of eye, and forward margin posterior to eye by a distance ½ to ⅔ as long as eye. Nostrils about ½ as long as eye, close to front of snout, and moderately oblique; the anterior nasal flap narrowly triangular, crossing the nasal aperture at about the mid-length of the latter. Mouth very little arched, the gape occupying a little less than ⅔ (about 60%) of breadth of head; anterior (upper) labial furrows extending between ½ and 3/5 of distance toward symphysis; rearward extensions of labial furrows reaching about ½ of distance toward first gill openings. Longest gill opening (5th) nearly ½ (44–46%) as long as distance between nostrils; first gill about 4/5 (80%) as long as fifth. Anterior margin of first gill concave, but not enough to expose the gill filaments, the 3rd to 5th gill openings nearly straight; first and second gills almost vertical, but the 3rd to 5th increasingly oblique.

Teeth smooth edged; $\frac{20\text{-}1\text{-}20}{21\text{-}21}$ in female of 462 mm. (type); $\frac{20\text{-}20}{20\text{-}20}$ in juvenile male of 339 mm.; the upper teeth slender, sharp pointed and erect along central ⅔ of mouth, but successively broader, more blade-like, and with cusp curving increasingly outward toward corners; the individual teeth largest along median third, or so, of each side of mouth; smaller both in region of symphysis and toward corner

of mouth, the outermost teeth much the smallest. Lower teeth triangular, with blade-like cusp, directed so strongly outward, all along each half of the tooth band, that the inner edges of the successive cusps form a practically unbroken cutting edge following the general contour of the jaw from the symphysis outward. No median lower tooth in the specimens seen. About 2 to 3 rows of teeth are in function simultaneously in the upper jaw, but one row only in the lower jaw.

The upper tooth band extends considerably beyond the outer limit of the gape on either side, i.e. into the mouth, and when viewed from below with mouth wide spread, is seen to follow an arc of long radius along either side of the mouth, the convexity facing inward (i.e. into the mouth), with these two lateral tooth-arcs interconnected around the symphysis of the jaws, as is the case in *S. ringens*. It is along the regions of transition between the median tooth-arc and the two lateral arcs that the individual teeth are the largest.

The lower tooth band extends considerably farther outward than the upper, on either side, and its arc of curvature is uniform, from the one end to the other.

Dermal denticles unevenly spaced, some close set, others more scattered, clothing the entire trunk (except for the lips) as well as the fins out very nearly to the margins of the latter; their arrangement random; the individual denticles rising rather steeply from the skin, on short pedicels; tridentate at margin but not definitely striate radially; their marginal teeth broadly triangular and sharp pointed, the median tooth considerably the largest; denticles on the belly similar to those on sides and back; those on lower surface of head and on fins smaller than those on body, more close set, less erect, pointing rearward at an angle of about 45°, not tridentate or only weakly so.

First dorsal fin about as long at base as length of eye, its upper contour continuously rounded, the rear corner sharp pointed, the free lower margin about as long as the base; origin of first dorsal about opposite to the tips of the pectorals (when these are laid back). Interspace between first and second dorsal fins about as long as head. Base of second dorsal fin about 1⅕ times as long as base of first dorsal and its area correspondingly larger; its anterior margin weakly convex; apex broadly rounded, distal margin nearly straight; rear corner sharp pointed; free lower margin about as long as the base; origin about over rear ends of bases of pelvics. First and second dorsal fin spines with only their points exposed.

Interspace between base of second dorsal and origin of caudal about ⅓ as long as interspace between first and second dorsals. Distance from rear corner of second dorsal to origin of caudal about ½ as long as eye.

Caudal about as long as head to origin of pectoral and about ½ as broad as long; upper margin nearly straight proximally but increasingly convex distally; the tip obliquely truncate; the lower rear margin with conspicuous subterminal excavation, a little more obtuse than a right angle; the lower anterior corner expanded as a broadly triangular lobe with slightly blunted apex; the lower anterior margin weakly convex, about ½ as long as upper margin.

Distance from lower origin of caudal to rear ends of bases of pelvics a little less than ⅖ as long as from origins of pelvics to axils of pectorals (38% on female of 462 mm.). Pelvics a very little longer at base than second dorsal; anterior margin weakly convex; distal margin nearly straight; their entire base anterior to origin of second dorsal. Pectorals with weakly convex margins and broadly rounded corners, reaching back very nearly as far as the origin of the first dorsal when the pectoral is laid back. The distal margins of all the fins are frayed; the dorsals and pelvics very narrowly, the pectorals somewhat more broadly so, the lower lobe of the caudal and the tip of the latter considerably more broadly still. On the 462 mm. specimen these fringes are rather regular. But they are irregular on the two smaller specimens, evidence that the present state of the fin margins is not normal, but was the result of rough treatment in the trawl.

Color. Uniformly almost black in life and after preservation in alcohol, below as well as above, without any evident pattern of darker and of paler markings. Lining of body cavity dark bluish gray, lining of mouth grayish white, teeth white.

Size. We dare not guess how large this shark may grow, for the largest specimen (the type) is a female.

Remarks. S. melas falls with *S. ringens* in shortness of snout, and large eyes, but differs quite sharply from *S. ringens* (according to available information as to the latter) in the shape of its caudal with truncate tip and definite lower anterior lobe; in the strong obliquity of the cusps of the lower teeth all along each side of the jaw from symphysis to outer corner;[33] apparently in pectoral fins considerably larger in area though perhaps no longer. It resembles *crepidator* more nearly in the shape of the caudal fin and in the shapes of the lower

[33]For an excellent illustration of the teeth of *ringens*, see Rey, 1928, p. 456, Fig. 152.

teeth, but differs conspicuously from *crepidator* (as the latter is pictured) in a much shorter snout, but much larger eyes, and in its smooth bladed but pronouncedly tridentate dermal denticles.[34] Furthermore, the upper labial furrows of *crepidator* are described by Günther (1870, p. 421) as nearly meeting in the mid line of the snout, and they are so shown in the sketch of the British Museum specimen, whereas their inner ends are separated by an interspace about as long as the eye in all three of our specimens of *melas*.

Among the members of the genus *Scymnodon* (as defined here) that have been named from the Pacific and Indian Oceans, *melas* shares its sharply tridentate dermal denticles with the Japanese *squamulosus* (Günther) 1877; also its very oblique lower teeth, the shape of its caudal, and its bodily proportions in general. But comparison with two excellent specimens of *squamulosus* from Japan, in the Museum of Comparative Zoology, shows that the two forms are clearly distinct, the lining of the mouth of *squamulosus* being blackish (grayish white in *melas*); its dermal denticles so much smaller than those of *melas* of a corresponding size that its skin feels velvety to the touch (rough in *melas*); and only the extreme tips of the dorsal fin spines of *squamulosus* are visible, if, indeed, they are not buried wholly in the skin, hence to be detected by touch only.

Habits and Range. The depths at which our three specimens were taken, added to the fact that it has never been taken any shoaler on grounds that are as intensively trawled as are the offshore parts of the Scotian Banks and of Georges Bank, are evidence that *melas* is restricted to depths greater than perhaps 300–350 fathoms. Nothing more is known of its habits. It is known so far only from the localities listed above (p. 233). But it may prove much more plentiful than the meagre record might suggest, for fishermen may well have confused it with the common black dogfish (*Centroscyllium fabricii*).

The discovery of this new *Scymnodon* extends the known range of this genus to the western side of the North Atlantic.

Genus ETMOPTERUS Rafinesque 1810

These little dark-colored deep-water squalids are characterized by having a prominent spine at the anterior margin of each dorsal fin,

[34]These are described and pictured as with up to seven radial ridges but with marginal teeth only weakly indicated in *crepidator;* and the sketch of the British Museum specimen mentioned above shows them as with three ridges only and no definite marginal teeth.

upper teeth with several cusps, but lower teeth with only one cusp, and those in each side of the jaw directed so sharply outward that the inner margins of the successive cusps form an almost unbroken cutting edge. Some members, also, of the genus, are luminescent; several of them are much darker colored below than above, and several have conspicuous dark markings of characteristic shape on the flanks, color-characters unusual among sharks.

The dozen species that had been described from one part of the oceans or another are divided by Fowler (1941, p. 246) into two subgenera, (a) *Etmopterus* Rafinesque 1810, with "second dorsal origin over or a little before ventral base; ventral origin slightly nearer subcaudal than pectoral origin," and (b) *Acanthidium* Lowe 1839, with "second dorsal origin behind ventral base; first dorsal origin midway between orbit and second dorsal origin." Examination of available material does not seem to us to justify subdivision of the genus on this basis. We think it likely, however, that the *E. paessleri* of Lönnberg 1907 from the Straits of Magellan and reported subsequently from Argentine waters by Lahille (1921, p. 63) will prove distinct generically, for its dermal denticles were described as having several smaller lateral spines surrounding the central spine, and the lateral cusps on its upper teeth as "nicht sichtbar". Further exploration, however, of this matter seems idle, since knowledge of *paessleri* is still limited to Lönnberg's original account, which did not include illustrations either of its dermal denticles or of its upper teeth.

Up to the present time, four species have been described from the North Atlantic with its tributary seas: — (a) *spinax* (Linnaeus) 1758 of North African and European waters from the Cape Verdes, Morocco and the Azores to Norway, including the Mediterranean and reported from southern Africa;[35] (b) *pusillus* (Lowe) 1839, Madeira (type locality), Cape Verde Islands, Canaries, Azores,[36] and also in Japanese waters or represented there by a very close ally;[37] (c) *hillianus* (Poey) 1861, West Indian-Cuban region, southern Florida, northward off the Atlantic slope of America to the offing of Chesapeake Bay;[38] and (d) *princeps* Collett, 1904, described originally from the Faroe region, and

[35]Gilchrist, 1922, p. 49.

[36]Goode and Bean's (1895, p. 1[illegible], Pl. 2, fig. 5) report of *pusillus* from St. Kitts, West Indies, is shown, by their illustration, to have been based in reality on a specimen of *hillianus*. And Jordan and Evermann's report of it from Cuba (1896, p. 219; 1896a, p. 55) doubtless refers equally to *hillianus*, which they did not recognize as a separate species.

[37]First described as *E. frontimaculatus* by Pietschmann (1907, p. 395; 1908, p. 654, Pl. 1, fig. 2, Pl. 2, fig. 2); subsequently as *E. pusillus* by Tanaka (1912, Vol. 5, Pl. 22; Vol. 6, p. 88).

[38]The *Etmopterus* reported from tropical West African waters by Poll (1951) as *hillianus* has proved to represent a new species described there as *E. polli* (pp. 240, 241).

reported subsequently from the offing of the Straits of Gibraltar.[39]

We thought it likely, earlier (Bigelow and Schroeder 1948, p. 488, footnotes 3, 4) that *princeps*, originally described from poorly preserved material, would prove to be identical with *spinax*. But receipt of the specimens listed below (p. 247), trawled on the continental slope off southern New England and off southern Nova Scotia, which agree in detail with Collett's account and illustrations, proves that *princeps* is in fact an easily recognizable species (p. 250).

The experimental trawlings of the "Oregon", in the northern part of the Gulf of Mexico have now brought to light two additional members of the genus that cannot be referred to any species of *Etmopterus* previously known, whether from the Atlantic or from the Indo-Pacific. They are described here as *E. schultzi*, n. sp. (p. 252), and as *E. virens*, n. sp. (p. 257). Examination, too, of the *Etmopterus* recently reported by Poll (1951) from tropical West Africa as *hillianus* has shown that a new specific name is needed for it also. We propose *polli* in honor of its discoverer (p. 241).

Final decision, whether the sharks that have been described as *spinax*, from southern African waters, and as *pusillus* from Japan, are actually identical with the *spinax* and with the *pusillus* of the North Atlantic must await a comparison of specimens from these widely separated seas. The status of *paessleri* is discussed above (p.238). Other species, referable to *Etmopterus*, that have been named from seas other than the North Atlantic, are: *lucifer* Jordan and Snyder 1902,[40] reported originally from Japan, where it appears to be common, and subsequently off Natal, southeastern Africa, from the East Indies, and widespread in Philippine waters; *granulosus* (Günther) 1880,[41] reported originally off the Coast of Chile, and subsequently off Natal, southeastern Africa,[42] and credited by Barnard (1925, p. 50) to the Hawaiian Islands; *brachyurus*, Smith and Radcliffe 1912,[43] from the Philippines; and *villosus* Gilbert 1905[44] from the Hawaiian region, the last two of which are known from the type specimens only. *Lucifer* is the only member of the Indopacific-Southern African-southern South American list of species that we have seen.

[39]Koefoed, 1932, p. 21, Sta. 25, Lat. 35°46′N, Long. 8°16′W, 2055 meters; as "*Spinax princeps*".

[40]Jordan and Snyder, 1902, p. 79; for list of locality references up to 1941, see Fowler, 1941, Vol. 13, p. 246.

[41]Günther, 1880, p. 19, Pl. 2, fig. C.

[42]Cape Point; Gilchrist, 1922, p. 49.

[43]Smith and Radcliffe, 1912, p. 679, Pl. 52; Fowler, 1941, p. 248.

[44]Gilbert, 1905, p. 580, Pl. 66; Fowler, 1941, p. 250.

Key to Species of *Etmopterus* of the North and Equatorial Atlantic, Mediterranean and Gulf of Mexico

1. Upper side of caudal fin very nearly as long as from tip of snout to rear edge of pectorals when latter are laid back; margins of fins fringed normally ..... *schultzi*, n. sp.
   Gulf of Mexico, p. 252

   Upper side of caudal fin very little longer, if any, than from tip of snout to origins of pectorals, and considerably shorter in some; margins of fins not fringed normally, though often much frayed out 2

2. Distance from rear ends of bases of pelvics to origin of lower side of caudal is about as long as from tip of snout to origins of pectorals 3

   Distance from rear ends of bases of pelvics to origin of lower side of caudal is at least no longer than from tip of snout to first gill openings 4

3. Rear end of base of first dorsal is about as near to origins of pelvics as it is to axils of pectorals; black and pale markings on rear part of trunk as in Figure 6A ..... *hillianus* (Poey) 1861
   Cuban-West Indian region and northward along the American Atlantic slope to the offing of Chesapeake Bay.

   Rear end of base of first dorsal is considerably nearer to axils of pectorals than it is to origins of pelvics; black and pale markings on rear part of trunk as in Figure 6D ..... *virens*, n. sp., p. 257
   Gulf of Mexico

4. Dermal denticles on back and sides of anterior part of trunk low, truncate, their apex either flat or weakly convex, without conspicuous median spine ..... *pusillus* (Lowe) 1839
   Eastern Atlantic from equatorial West Africa[45] to Canaries, Madeira and Azores.

   Dermal denticles on back and sides of anterior part of trunk with conspicuous median spine, either conical, thorn-like or bristle-like in form 5

5. Distance from rear ends of bases of pelvics to origin of lower side of caudal nearly or quite as long as upper side of caudal, and about as long as interspace between first and second dorsals ..... *polli*, n. sp.
   Equatorial West Africa, p. 241

   Distance from rear ends of bases of pelvics to origin of lower side of caudal is not more than ⅔ as long as upper side of caudal, and is shorter than interspace between first and second dorsals 6

6. Belly at least slightly but definitely darker than sides and back with abrupt line of transition; the black of the lower surface extending upward

[45] We have received a fine specimen of *pusillus*, 167 mm. long, from Dr. Max Poll, from equatorial West Africa, Lat. 6°08′S, Long. 11°24′E. For an excellent colored illustration of *pusillus*, see Braganza, 1904, Pl. 2, fig. 2.

on rear part of sides as a sharply outlined flank mark of shape shown in Figure 6C; dermal denticles slender, bristle-like. . .*spinax* (Linnaeus) 1758
Eastern Atlantic, including Mediterranean, from the Cape Verde Islands, Morocco and the Azores to Norway; also reported from southern Africa (p. 238, footnote 35)

Back and sides black or blackish brown like belly; no definite flank mark; dermal denticles low, conical to thorn-like ..... *princeps*, Collett, 1904
Faroes-Hebrides region and offing of Straits of Gibraltar in Eastern Atlantic, American slope off southern Nova Scotia, off Georges Bank, and off southern New England in Western. p. 246.

Etmopterus polli, n. sp.
Figure 7

Type specimen. Male, 197 mm. long; tropical West Africa, Lat. 6°08′S, Long. 11°24′E, 350–380 meters, M.C.Z. No. 38001, received from Dr. Max Poll. *Additional material:* five males and five females, 106–232 mm. long from the above locality and from Lat. 10°45′S, Long. 13°10′E, 350 meters, also contributed by Dr. Max Poll and all in Museum of Comparative Zoology.

Description. Proportional dimensions, in per cent of total length, of male 197 mm. long (type), and male of 213 mm.

Trunk at origin of pectoral: breadth 12.2, 9.9; height 10.1, 9.4.

Snout length in front of: outer nostrils 1.3, 1.4; mouth 9.6, 9.4.

Eye: horizontal diameter 5.1, 4.7.

Mouth: breadth 7.1, 6.6.

Nostrils: distance between inner ends 3.5, 3.3.

Labial furrow length: 4.6, 4.7.

Gill opening lengths: 1st 1.8, 1.4; 3rd 1.8, 1.4; 5th 1.8, 1.6.

First dorsal fin: vertical height 4.6, 4.7; length of base 5.6, 6.1.

Second dorsal fin: vertical height 4.8, 5.2; length of base 7.6, 8.0.

Caudal fin: upper margin 21.9, 23.4; lower anterior margin 12.2, 9.9.

Pectoral fin: outer margin 10.1, 8.9; inner margin 6.6, 6.1; distal margin 7.6, 6.7.

Distance from snout to: 1st dorsal 34.6, 33.3; 2nd dorsal 57.5, 54.5; upper caudal 78.1, 76.6; pectoral 23.9, 23.5; pelvis 49.3, 48.8.

Interspace between: 1st and 2nd dorsals 17.2, 15.0; 2nd dorsal and caudal 13.2, 14.1; pelvic base and caudal 15.7, 17.9.

Distance from origin to origin of: pectorals to pelvics 25.4, 25.3.

Trunk at first dorsal (where highest) between 1/6 and 1/7 (16%)

as high as it is long to origin of caudal; its thickness there about $\frac{2}{3}$ as great as height, narrowing thence rearward and increasingly flattened sidewise with caudal peduncle about $\frac{1}{2}$ as thick as high; trunk thickest anteriorly, breadth of head at level of first gill openings being about $1\frac{1}{4}$ times as great as breadth at first dorsal. Head, to origin of pectorals a little less than $\frac{1}{3}$ (30%) of length of trunk to origin of caudal; flattened above and narrowed only a little abreast of the eyes; dorsal profile of head nearly straight, sloping evenly forward. Snout fleshy as is usual in the genus, its anterior outline forming an angle of a little more than 90°, with rounded tip. Length of snout to mouth opening about $\frac{1}{2}$ (53%) of head, its length to eye about $\frac{1}{5}$ (21%). Eye oval with pointed rear corner, between 2 and 3 times as long as high, its horizontal diameter about $\frac{1}{2}$ (51%) as long as snout in front of mouth opening. Spiracle about 29 per cent as long as eye; behind eye by a distance about $\frac{1}{2}$ as long as eye, and about level with upper edge of eye. Nostril close to outer anterior margin of snout; about 60 per cent as long as eye; anterior nasal flap narrowly pointed, much as in *schultzi* (p.253); crossing nasal aperture a little outward from mid-length of latter. Mouth moderately arched, the gape occupying about $\frac{2}{3}$ (63%) of breadth of head. Upper labial furrows extending inward about 30 per cent of distance toward mid-line of head; rearward extensions of labial furrows reaching back from corner of mouth about $\frac{1}{2}$ the distance toward first gill openings.

Gill openings about $\frac{1}{2}$ as long as distance between inner ends of nostrils, anterior margins concave, but not enough so as to expose tips of gill filaments.

Teeth smooth edged, of the usual etmopterid shapes; $\frac{29}{16\text{-}1\text{-}16}$ in type specimen, $\frac{27 \text{ to } 34}{28 \text{ to } 30}$ in other specimens 207–232 mm. long. Upper teeth mostly with 5-7 cusps, the median cusp much the longest, the outermost cusp on each side much the shortest; a few teeth with only 3 cusps. Lower teeth with the cusp directed so strongly outward that the inner cutting edges are practically parallel with the general contour of the jaw; median lower tooth in type but not in ten other specimens examined. Mostly three rows in function simultaneously in upper jaw, one row in lower jaw.

Dermal denticles slender, thorn-like, stiff, thus intermediate in shape between the conical thorn-like denticles of *princeps* and the bristle-like denticles of *hillianus* and *schultzi;* rising steeply, with the tips curving rearward, making the skin rough to the touch; the bases 4-angled but

mostly hidden in the skin. The denticles are sparsely distributed, in random arrangement on the anterior parts in general, but are in about 12 regular longitudinal rows along the tail sector of the trunk. Space between nostrils, and mid-belt of snout thence rearward to mouth either entirely naked, or with only an occasional denticle, so that the skin there feels glossy smooth to the touch. Basal 1/3–1/2 of fins sparsely denticulate, but their marginal zones naked.

First dorsal fin at base about 1.1 times as long as eye in type, 1.3 times in specimen 213 mm. long, of the characteristic etmopterid shape; its origin posterior to origin of pectorals by a distance about 2/3 as long as from tip of snout to mouth. Interspace between first and second dorsals (to first sensible elevation above general profile of back) nearly 3/4 (73%) as long as head to origin of pectorals in type, nearly 2/3 (64%) in specimen 213 mm. long. Origin of second dorsal about over rear ends of bases of pelvics (in male); its base about 1 1/3 times as long as base of first dorsal; its rear margin moderately concave; free lower margin about 3/4 as long as base; its rear corner sharp. Dorsal fin spines slender and needle-sharp, the second about 1.7 times as long as the first, its tip about level with the apex of the second dorsal fin. Distance from rear end of base of second dorsal fin to origin of upper side of caudal fin a little shorter than interspace between first and second dorsals; and a little more than 1/2 (55%) as long as head to origin of pectorals in type, 3/5 as long in specimen of 213 mm. Upper side of caudal fin about as long as from tip of snout to third gill openings; the tip obliquely truncate; lower rear margin with subterminal excavation forming an angle of about 150°, the lower anterior corner forming a low, well-rounded lobe as pictured (Fig. 7). Lower anterior margin of caudal about 1/2 (56%) as long as upper margin. Distance from origin of lower side of caudal to rear ends of bases of pelvics nearly as long as from tip of snout to first gill openings, and about as long as interspace between first and second dorsals. Pelvics a little shorter at base than second dorsal; outer corner well rounded; rear end of pelvic bases about under second dorsal spine. Pectorals reaching a little beyond first dorsal fin spine when laid back, truncate at tip with rounded corners.

The horny rays along the distal margins of all the fins are frayed out, but in such varying degree as to suggest that their present state has resulted from rough treatment, rather than that it represents the normal condition.

Claspers of mature males cylindrical, tapering to slender tips, the

latter fleshy with one sharp spur exposed on the outer side, when not in function.

Color. Back and upper part of sides dark grayish brown, merging into black along lower surface of head, on belly, and in a narrow median band along ventral side of tail sector of trunk. The upper parts are of nearly as dark a shade as the belly; the sides seem to be plain-colored at first sight. Close examination, however, under a strong light, shows that the black of the lower surface spreads upward and rearward in a narrow band along the lower edge of the anterior part of the caudal peduncle on each side; also upward close behind the respective pelvic fin, then rearward as a definitely outlined, flank mark of the shape illustrated (Fig. 7), which is preceded anteriorly, after a short gap, by a second narrow oval black band, corresponding to the anterior extension of the flank mark to be seen on *E. spinax* (Fig. 6C); *E. hillianus* (Fig. 6A), *E. lucifer* (Fig. 6B), and *E. virens* (Fig. 6D). The top of the head is marked with a small vaguely outlined pale yellowish spot, and there is a pale spot close above the rear part of the eye in some specimens, but perhaps not in all. The margins of the pectoral, dorsal and pelvic fins are pale and translucent, but the tip of the caudal is smoky. Teeth cream white; lining of mouth dark bluish gray; lining of body cavity black.

It is interesting that the black dots and dashes that mark the side of several other members of the genus (pp. 255, 261) either are not represented at all on *polli*, or if they are present, are entirely concealed from view by the dark and dense pigmentation.

Size. The claspers of males 212–232 mm. long appear to be fully formed, suggesting a maximum length of perhaps 250–300 mm. at most.

Remarks. The specimens described here as *E. polli* were reported originally by Poll (1951, pp. 65–69) as *E. hillianus*. But a comparison with the considerable series of *hillianus* in the Museum of Comparative Zoology, from the type region (Cuba), has shown that the West African form differs quite sharply from *hillianus* in stouter and more sparsely distributed dermal denticles resulting in a rougher skin; in the nakedness of the midzone of the lower surface of its snout (densely denticulate in *hillianus*); in a somewhat longer head relative to the tail sector of the body (head about 1.4 times distance from pelvic base in *polli* but only about 1.1 times as long in *hillianus*). *Polli* seems also to lack the pattern of black dots and dashes (perhaps luminescent) to be seen on the sides of *hillianus*, and while the anterior portion of the

black flank mark is continuous with the posterior portion in *hillianus* it is separate from the posterior portion in *polli* (cf. Fig. 6A with Fig. 7). Neither is there any likelihood of confusing *polli* with the new species *virens* (p. 257), so noticeably does it differ from the latter in its uniformly dark coloration; in the shape of the black flank marks on the rear part of the trunk (cf. Fig. 7 with Fig. 10); and especially in the relatively much shorter tail sector of its trunk, to list only the most conspicuous differences. *E. polli* recalls *E. princeps*, *E. pusillus*, *E. schultzi*, and newly-caught specimens of *E. spinax* among North Atlantic species, and *E. granulosus* of mid-latitudes of the southern hemisphere, in its dark coloration and proportional dimensions in general. But it differs from *spinax* in the nakedness of the mid-zone of the lower side of its snout (denticulate in *spinax*), in the linear arrangement of the denticles on the tail sector of its trunk (random there in *spinax*), in that the interspace between its pelvics and the lower side of its caudal is about as long as from tip of snout to second gill openings (only about as long as from tip of snout to corners of mouth in *spinax*), and in the shape of its black flank marks (cf. Fig. 6C with Fig. 7). More slender dermal denticles, narrower nasal flap, somewhat shorter caudal relative to length of head, smaller, more truncate pectorals reaching considerably farther rearward, the presence of the black flank mark and of the pale interocular spot on the top of the head, and much smaller size at sexual maturity mark it off from *princeps*. Distinctive differences between *polli* and *pusillus* are the thorn-like dermal denticles of the former (mostly truncate in *pusillus*); nakedness of its internarial space and of the mid-belt of the snout thence rearward to the mouth (uniformly denticulate in *pusillus*); much shorter interspace between its first and second dorsal fins, relative to the length of the head and to the total length of the fish; pectoral fins reaching considerably farther rearward; also in the presence on the rear part of its trunk of definitely outlined black flank marks.[46] Comparison with our considerable series of *E. schultzi* (p.252)shows *polli* as differing from the latter in a considerably shorter caudal fin in relation to other proportional dimensions; in a longer head but shorter interspace between the first and second dorsals; in the truncate shape of its pectorals (rounded in *schultzi*); in the shape of its caudal fin with more prominent lower anterior corner; in stiffer and more thorn-like dermal denticles; in the nakedness of its inter-

[46]We have, for comparison, a female *pusillus* about 280 mm. long, in a fair state of preservation, from Madeira, and a female of 167 mm., in excellent condition, from tropical West Africa, Lat. 6°08′S; Long. 11°24′E, received from Dr. Poll.

narial space and of the mid-belt of the lower surface of the snout thence rearward to the mouth; in the presence of the definitely outlined black flank mark on the rear part of the trunk (indistinct in *schultzi*, p.255);and in that the present frayed out state of the margins of its fins seem not to represent the normal condition.

Polli falls with *granulosus* in the nakedness of the mid-belt of the lower surface of its snout. But our West African specimens differ from *granulosus* as characterized and pictured by Günther (1880, p. 19, Pl. 2, fig. C),[47] in that the distance from snout to lower jaw occupies only about 35–40 per cent of the length of the head (to pectoral fins) in them, but ½ the length of the head in *granulosus;* that the distance from the rear ends of the bases of the pelvics to the lower origin of the caudal fin is longer than the interspace between the first and second dorsal fins in *polli* but shorter than the interdorsal space in *granulosus*; and that the base of the second dorsal fin is about ½ as long as the interdorsal space in *polli* but only about ⅓ that long in *granulosus.* Günther also describes the skin of *granulosus* as "granular", suggesting that its dermal denticles resemble the truncate denticles of *pusillus* (p. 240) rather than the thorn-like or bristle-like denticles of other members of the genus — except on the tail where he characterizes them as "minute spinelets." And he adds that the back of the tail is "naked" in *granulosus*, which is not the case in our specimens of *polli*.

Range. Specimens referable to *polli* have been reported only off the coast of tropical West Africa, between latitudes 5°39′S, and 11°53′S; from depths of 164 to 279 fathoms (300–510 meters, Poll, 1951, pp. 65–68, as *E. hillianus*). But the species must be decidedly common there, at the proper depth, for trawl hauls at 9 stations, by the Belgian expedition of 1948–1949 yielded 162 specimens, most of which, at least, were of this species.[48]

Etmopterus princeps Collett 1904
Figure 8

Our good fortune in obtaining the excellent series listed below, during the experimental trawlings carried out by the Woods Hole Oceanographic Institution on "Caryn" during the summer of 1949 and on "Cap'n Bill II" during the summer of 1952, enables us to add to Collett's original account of this species which was based on rather

[47]This is all we have to go upon.

[48]One specimen, at least, proves to be a *pusillus* (p.245, footnote 46), so it is possible that there may have been others of that species that were overlooked among the more numerous *polli*.

poor material. They also extend the known range of *princeps* to the western side of the North Atlantic.

Study material. Forty-seven specimens, 7½–24 inches (190–605 mm.) long, of both sexes, including a male with fully formed claspers; trawled on the continental slope off southern Nova Scotia, off Georges Bank and off southern New England, as above, at depths of 310–520 fathoms, between latitudes 42°39′ and 39°52′N, and between longitudes 63°58′ and 70°05′W.

Description. Proportional dimensions, in per cent of total length, of mature male 545 mm. long and female of 593 mm., both in Museum of Comparative Zoology.

Trunk at origin of pectoral: breadth 10.3, 12.2; height 7.9, 9.3.
Snout, length in front of: nostrils 1.1, 2.0; mouth 9.4, 9.8.
Eye: horizontal diameter 4.0, 4.0.
Mouth: breadth 7.9, 7.7.
Nostrils: distance between inner ends 2.8, 3.5.
Labial furrow length from angle of mouth: upper 4.4, 6.1.
Gill opening lengths: 1st 1.8, 2.0; 3rd 1.8, 1.7; 5th 1.6, 1.4.
First dorsal fin: vertical height 3.1, 3.4; length of base 5.1, 5.4.
Second dorsal fin: vertical height 4.6, 5.1; length of base 7.5, 7.6.
Caudal fin: upper margin 22.8, 22.0.
Pectoral fin: outer margin 9.7, 9.8; width 5.7, 6.9.
Distance from snout to: 1st dorsal 31.7, 34.3; 2nd dorsal 60.3, 60.6; upper caudal 77.2, 78.0; pectoral 21.6, 25.0; pelvics 53.7, 55.3.
Interspace between: 1st and 2nd dorsals 23.5, 20.9; 2nd dorsal and caudal 9.4, 9.8; pelvic base and caudal 14.7, 11.8.
Distance from origin to origin of: pectorals to pelvics 32.1, 30.4.

Trunk at first dorsal (where highest) about 1/7–1/8 as high as its length to origin of caudal fin, moderately flattened sidewise rearward from pectorals, its thickness at first dorsal about 3/5–3/4 its height there. Head flattened above, narrowed somewhat abreast of eyes, and noticeably broad; its width at level of corners of mouth and of first gill openings a little less than ½ (47%) as great as distance from snout to origin of pectorals; its length (to pectorals) between ⅕ and ¼ of total length in specimens in which the snout is not distorted. Tail sector from center of cloaca to origin of caudal fin about between ⅕ and ¼ as long as body sector (snout to cloaca) and 45–70 per cent as long as head to origin of pectorals.

Snout thick, fleshy (as usual in this genus), low-wedge shaped in

front with rounded tip, in specimen in which it is not distorted; its length in front of mouth 2/5–1/2 (39–50%) of length of head.[49] Eye about 2½ times as long as high, its horizontal diameter about 2/5 as long as snout in front of mouth opening. Spiracles about ⅓ as long as eye, at about level of eyes, and posterior to eyes by a distance about ⅔ as long as eye. Mouth very low-arched or nearly straight, its corners with short but conspicuous labial furrows extending inward about ⅓ of distance towards the respective symphysis, and continued rearward and outward, from each corner of mouth for a distance about as long as the eye. Nostrils close to front of snout, strongly oblique, about as long as eye; inner anterior margin expanded as a broadly triangular flap with blunted tip, crossing outer part of nasal aperture. First to third gill openings ⅓–½ as long as eye, the fifth a little shorter. Anterior margins of first to third gills so deeply concave that the tips of the respective gill filaments are more or less exposed to view, at least on large specimens.

Teeth smooth edged; $\frac{32}{50}$ in adult male of 545 mm.; $\frac{30}{40}$ in male of 404 mm.; $\frac{29}{48}$ in female of 593 mm.; a range suggesting that the number tends to increase with growth; the lower jaw with or without a median tooth. Upper teeth mostly with 5 cusps in adults, the median cusp much the largest, the outermost much the smallest; those of middle sized specimens either with the outer pair of cusps minute, or with only 3 cusps; small specimens with 3 cusps only. Lower teeth with cusps directed outward at an angle of as much as 70–75° in some cases, in others almost parallel with jaw, the inner margins of successive teeth together forming a nearly continuous cutting edge; those toward corners of jaws much smaller than those along central part.

Dermal denticles low, thorn-like, with slightly blunted tip, and nearly erect except with points turning a little rearward; more or less prominently striate longitudinally, on quadri-radiate bases that are mostly hidden in the skin; the denticles so sparsely distributed that the skin is exposed between them, the arrangement random over the anterior part of the trunk, but giving place to longitudinally linear arrangement on caudal peduncle and out along caudal fin. On adults the entire trunk, including the skin around the gill openings, and between them, is rough with denticles except for the area between the nostrils on the lower side of the snout which is sparsely denticulate,

[49] On one of our larger specimens, an adult male of about 545 mm., the tip of the snout is shrivelled, having dried by accident; hence it is now shorter than when the specimen was first taken; see legend to Figure 8.

or on some specimens naked, and along the upper lip, which is naked and velvety to the touch. On half-grown specimens and smaller this naked labial belt is broader, the internarial area is wholly naked, and the mid-belt of the lower side of the snout thence rearward may bear only a few scattered denticles. In this case, the pattern of mucous pores (obscured by the denticles on adults) is clearly visible. All but the outermost zone of the pectoral, dorsal and pelvic fins is rough with denticles, also the upper side of the caudal out to its margin. But the lower side of the caudal, outward from the caudal axis, is mostly naked. The fins are of the ordinary type, i.e. the margins not normally fringed, though very thin and more or less frayed out on all the specimens we have seen. First dorsal of usual etmopterid shape, its base about ¼–⅓ (average 30% on four specimens) as long as interspace between first and second dorsals; its origin posterior to a perpendicular at axils of pectorals by a distance between ¼ and ⅓ as long as interspace between dorsals. Interspace between dorsals from a little shorter to a little longer than head. Base of second dorsal about 1½ times as long as base of first dorsal, including the respective fin spines (1.4 times on 545 mm. male); distal margin weakly concave, free lower margin about as long as anterior margin from point of emergence of fin spine. Second dorsal spine about twice as long as first dorsal spine, its origin slightly but definitely posterior to rear ends of bases of pelvics. Interspace between second dorsal and origin of caudal ⅖ to about ½ (40–47%) as long as interspace between first and second dorsals. Caudal about as long (0.9–1.1 times) as head and about as long (0.97–1.05) as interspace between dorsals; about ⅓ as broad as long, with definite lower anterior corner, not, however, extended as a separate lobe; lower posterior outline slightly sinuous with well marked subterminal indentation, the tip obliquely truncate. Pelvics a little longer at base than base of second dorsal; rear pelvic corners angular. Pectoral with nearly straight anterior margin merging into moderately rounded distal inner margin around to axil; extreme length of pectoral from origin about ⅓ to a little less than ½ (33–44%) as great as length of head, its base, from origin to axil, about as wide as from tip of snout to level of center of eye. Claspers of mature males moderately stout, attached to the pelvic fins very nearly to the tips of the latter, and extending only a little beyond; tips of the claspers widely expanded when in function, with 4 sharp thorns, one of them covered with skin. On one mature male (Fig. 8) the left-hand clasper, with its thorns, is spread, exposing the orifice of the sperm channel, but the tip of the

other clasper is closed and conical, with the thorns concealed entirely.

Color. The trunk, as a whole, of half-grown specimens and adults is very dark, blackish brown, or uniform black; the belly is somewhat darker than the back on some specimens after preservation in alcohol, but not on others; no definite flank mark. The outer parts of all the fins are about as dark as the trunk (if the pigmented skin has not been rubbed off by rough treatment) except that the lower rear corner of the second dorsal fin is whitish over a larger or smaller area on some partly grown specimens, perhaps on all, though not on adults. The anterior surface of the outer part of each gill arch (exposed by the deeply excavated anterior contour of the respective gill opening), is whitish; the teeth white and therefore conspicuous against the sooty or black lining of the mouth; the lining of the body cavity sooty or black. It is interesting that no trace is to be seen of the rows of dark dots and dashes, or of the pale interocular spot, that characterize various other members of the genus.

Size. A male, about 545 mm. long, appears to be fully mature sexually, which suggests that the original specimens, about 750 mm. long, from the Faroe region, were about as large as the species grows.

Luminescence. There is no reason to suppose that *princeps* is luminescent — at least we have seen no evidence of light emission by any of the specimens that we have handled while they were still alive.

Remarks. Comparison of our series of *princeps* with two specimens of *spinax* from Norway and two from the Mediterranean, in good condition, bears out Collett's (1904, 1905) belief that the former differs from the latter in a wider head relative to the length of the snout, in longer gill openings, in shape of dermal denticles, and in color. Thus the breadth of the head is 1.2–1.4 times as great as the length of the snout (to the mouth) in four *princeps*, but only about as great as the length of the snout in the four specimens of *spinax;* the longest gill openings are $\frac{1}{3}$–$\frac{1}{2}$ as long as the eye in *princeps* but about $\frac{1}{7}$–$\frac{1}{3}$ only in the *spinax;* the conical, thorn-like denticles of *princeps* differ noticeably from the bristle-like denticles of *spinax;* and none of our *princeps* show any trace of the black flank marks to be seen on the rear part of the sides in *spinax*, more or less conspicuously, depending on whether the color of the upper parts of the specimens examined has faded.

Superficial examination is all that is needed to distinguish *princeps* from all the remaining North and Tropical Atlantic species of its genus. The most conspicuous features marking it off from *hillianus*,

and from *virens* are its uniformly black or blackish brown color, without definite flank markings, and its large gill openings; likewise the much greater length to which it grows. Its short thorn-like denticles mark it off further from *hillianus*, and a relatively much shorter tail sector of its trunk from *virens*. It resembles *pusillus* and the new species *schultzi* (p. 252) and *polli* (p. 241) in its uniformly dark coloration. But a much shorter caudal fin, longer gill openings, much larger size at maturity, fins that are not fringed normally, and short, thorn-like denticles separate it from *schultzi;* its conical thorn like denticles, a caudal fin at least as long as the head, the shape of the caudal and a more rounded pectoral separate it from *pusillus*.

Turning now to the species of *Etmopterus* that have been named from more distant seas, we find *princeps* set apart from *E. paessleri* by the teeth and dermal denticles — if, indeed, *paessleri* falls properly in this genus at all (p.238); from *villosus* by the position of its first dorsal fin nearer to the spiracles than to the second dorsal (nearer to the second dorsal than to the spiracles in *villosus*); from *brachyurus*[50] by a much shorter tail sector of the trunk as compared with the body sector; from *lucifer* similarly by a much shorter tail sector, as well as by uniformly dark coloration, with neither black flank marks nor pale interocular spot. *Princeps* appears to agree very closely indeed with *granulosus* in relative dimensions, as it also does in color. But, to judge from Günther's (1880, p. 19) description, which is all we have to go upon,[51] the dermal denticles on the anterior part of the body of *granulosus* ("granules") differ in shape from those on the tail, where he characterized them as "in the form of minute spinules." That is to say, they reproduce the condition to be seen in *pusillus* rather than the condition in *princeps*, where the denticles are conical thorn-like on the posterior part of the sides as well as anteriorly. We cannot carry our comparison farther, lacking either a detailed description of *granulosus* or specimens of the latter, for comparison with *princeps*.

Habits. Evidently *princeps* is confined to deep water, recorded depths for it being 310–520 fathoms in the Western Atlantic, 410–602 fathoms in the region of the Faroes and Hebrides, and 1134 fathoms off the Straits of Gibraltar.

Range. The recent captures, listed above, extend the known range of

[50] As described and pictured for the type specimen of *brachyurus* by Smith and Radcliffe (1912, p. 679, Pl. 52) and by Fowler (1941, p. 249).

[51] The dermal denticles of *granulosus* have not been figured either by Günther (1880) or by Barnard (1925).

E. princeps from the Faroe-Hebrides region, and from the offing of the Straits of Gibraltar to the Western Atlantic slope off southern Nova Scotia, off Georges Bank and off southern New England.

Etmopterus schultzi, n. sp.
Figure 9

Type. Male, 270 mm. long, "Oregon" Sta. 279, Lat. 29°11′N, Long. 86°53′W; 305 fathoms, February 24, 1950 (U. S. Nat. Mus. No. 113,381). Also 38 males and females, 195 to 300 mm. long, from "Oregon" trawlings in northern part of Gulf of Mexico, 220 to 400 fathoms.[52]

Description. Proportional dimensions, in per cent of total length, of male of 270 mm. (type) and female, 255 mm.

Trunk at origin of pectoral: breadth 9.6, 10.2; height 7.8, 9.0.

Snout length in front of: outer nostrils 1.5, 1.6; mouth 9.4, 9.1.

Eye: horizontal diameter 4.8, 5.1.

Mouth: breadth 7.8, 7.5.

Nostrils: distance between inner ends 3.3, 3.1.

Labial furrow length: 4.1, 4.3.

Gill opening lengths: 1st 1.1, 1.6; 2nd 1.1, 1.6; 3rd 1.1, 1.6; 4th 1.1, 1.6; 5th 1.1, 1.6.

First dorsal fin: vertical height 2.6, 2.3; length of base 4.5, 4.3.

Second dorsal fin: vertical height 5.5, 5.1; length of base 8.2, 8.6.

Caudal fin: upper margin 25.5, 23.0.

Pectoral fin: outer margin 7.4, 7.5; inner margin 3.9, 4.3; width 5.9, 5.5.

Distance from snout to: 1st dorsal 31.1, 32.9; 2nd dorsal 54.1, 55.7; upper caudal 74.5, 77.0; pectoral 21.1, 19.6.

Interspace between: 1st and 2nd dorsals 18.5, 18.5; 2nd dorsal and caudal 12.2, 13.0; base of pelvics and caudal 15.2, 12.6.

Distance from origin to origin of: pectorals to pelvics 29.6, 33.3.

Trunk thickest opposite pectorals, narrowing rather evenly rearward, its height at first dorsal (where highest) about 15 per cent as great as its length to origin of caudal. Head about 28 per cent of trunk to caudal; body sector (snout to center of cloaca) about 3½

[52] "Oregon" Station 270, Lat. 29°23′N, Long. 82°25′W, 220 fath., Feb. 17, 1950; Sta. 271, Lat. 29°24′N, Long. 86°56′W, 300 fath., Feb. 18, 1950; Sta. 279, Lat. 29°11′N, Long. 86°53′W, 305 fath., Feb. 24, 1950; Sta. 319, Lat. 29°20′N, Long. 87°25′W, 315 fath., April 28, 1951; Sta. 321, Lat. 29°27′N, Long. 87°19′W, April 28, 1951; Sta. 482, Lat. 28°57′N, Long. 88°43′W, 210 fath., Sept. 7, 1951; Sta. 542, Lat. 27°41′N, Long. 94°59′W, 250–300 fath., April 16, 1952; and Sta. 549, Lat. 26°59′N, Long. 96°07′W, 300–400 fath., April 18, 1952.

times as long as tail sector from center of cloaca to origin of caudal. Head flattened above, slightly narrowed at eyes, its breadth abreast mouth and first gills about 1.4–1.5 as great as distance from front of snout to mouth. Snout thick, fleshy, soft, obtusely rounded in front, its length in front of mouth a little less than ½ (44%) of head to origin of pectorals. Eye about twice as long as high, its horizontal diameter about ½ (51%) as long as snout in front of mouth. Spiracles about ¼ as long as eye; a little above horizontal axis of eye, and behind latter by a distance about ⅕ (22%) as long as eye. Nostrils very close to anterior margin of snout, as characteristic of the genus; about ½ as long as eye; anterior (inner) margin expanded as a narrow pointed lobe crossing nasal aperture; inner subdivision of nasal aperture about twice as long as outer subdivision. Mouth very low arched, the gape occupying about ⅔ of breadth of head; labial furrows reaching inward about ⅓ of distance toward symphysis; extended as a conspicuous furrow outward and rearward beyond corner of mouth for a distance about 45 per cent as long as eye. Gill openings about ⅓ as long as distance between nostrils, and about ¼ as long as eye (about ⅓ as long in specimen of 254 mm.)[53], their anterior outlines concave, but not enough so as to expose the tips of the gill filaments.

Teeth smooth edged, $\frac{38}{32}$ in type specimen, $\frac{32}{32}$ in female of 254 mm.; uppers mostly with 7 cusps, a few with 8 (4 laterals on the one side, 3 on the other), a few with only 5 or 6; median cusp considerably the longest and stoutest, the lateral cusps on each side graded in length outward. Lower teeth with the cusp directed so strongly outward as to form a practically unbroken cutting edge approximately parallel with the jaw. Dermal denticles minute, bristle-like, curving so strongly rearward that the distal half of their length is approximately parallel with the skin; the tips hair-fine, and flexible; the bases quadriradiate, but mostly concealed in the skin. The denticles are close spaced over the trunk as a whole, including the entire lower surface of the head, excepting only along the upper and lower lips;[54] in random distribution, not in linear arrangement anywhere. All the fins, also, are closely denticulate out very nearly to the fringed marginal zone (Fig. 9E).

Base of first dorsal fin about ¼ (24%) as long as interspace between first and second dorsals; its upper contour rounded, the free lower margin about ⅔ as long as the base; its origin posterior to axils of

[53] The softness of the skin makes precise measurements difficult.

[54] On specimens preserved in alcohol the denticles are so covered with coagulated mucus that it is necessary to scrub them clean, to expose their shape and arrangement.

pectorals by a distance about as long as from corners of mouth to origins of pectorals. Interspace between first and second dorsals nearly as long as head, and a little less than ¾ (74%) as long as caudal fin. Second dorsal about 1½ times as large as first dorsal in linear dimensions, its anterior margin nearly straight, distal margin weakly concave, apex bluntly angular; free lower margin about as long as anterior margin from point of emergence of fin spine; origin about even with rear ends of bases of pelvics. Second dorsal spine extending out nearly to level of apex. Interspace between second dorsal and caudal about ⅔ (66%) as long as interspace between first and second dorsals. Caudal about 1.2 times as long as head, and 1.4 times as long as interspace between first and second dorsals; about 3½ times as long as broad, its tip rounded; the lower rear margin increasingly concave toward tip but without definite subterminal notch; lower anterior corner a little more obtuse than a right angle, not produced as a lobe; lower anterior edge nearly straight. Interspace between lower origin of caudal and rear ends of bases of pelvics about ½ as long as interspace between rear ends of bases of pelvics and axils of pectorals. Pelvics subquadrate, their anterior and distal margins nearly straight; anterior margin about as long as base. Pectorals with weakly convex anterior margin, grading insensibly into broadly and evenly rounded distal and inner margins around to axil; maximum length of pectoral about 2/5 as great as distance from snout to level of first gill openings, the rear margin falling considerably short of the first dorsal spine when the pectoral is laid back.

The outstanding feature of the species is that the outer ends of the horny terminal rays (ceratotrichia) of all the fins are not only thicker than in other species of the genus, but are free from the skin so that they form a conspicuous fringe. Since this is true of all the specimens examined, though some of them were still alive when we first handled them, we see no reason to doubt that this is the normal state. But the fact that the edges of the skin, whence the rays emerge, are somewhat ragged in varying degree from place to place, suggests that the fringe-like conditions may be a growth character. However, we have not been able to check the state of the fins either on unborn embryos, or even on very young free-living specimens. In the case of the pectorals, the fringe around the distal margin occupies about ⅕–⅙ of the length of the fin, grading down to nothing at origin and axil. The fringe is narrower (hence less conspicuous) on the dorsals and pelvics; very narrow indeed along the upper edge of the caudal, though it is evident

even there on close examination.

Color. Back and upper parts of sides very dark sooty gray, with brownish cast, the top of the head with a vaguely outlined pale yellowish spot between the eyes; the belly black. On specimens preserved in alcohol the line of demarkation between the slightly darker belly and the slightly paler sides above is rather definite in most cases. On the type specimen — when slightly dried — the black of the lower surface extends upward and forward as a vaguely outlined band on either side above the paler base of the respective pelvic fin, reminiscent of the much more conspicuous and more definitely outlined black flank mark to be seen on several other members of the genus, such as *virens, lucifer, spinax* and *polli.* But some other specimens, which seem to have retained their normal coloration better, show no sign of this. The lower margin of the caudal axis, near the tip, is narrowly edged with black. The fins otherwise are paler generally than the trunk, except that the tip of the caudal is dark-margined at least on some specimens. Other than that, the free rays that edge the fins are colorless and nearly translucent so that the marginal fringe of the pectorals shows whitish against the dark sides when the fins are laid back. Faded specimens also show two irregular lines of short, very narrow, black dots and dashes along each side, the upper row extending from over the origin of the pectoral fin back to about opposite the tip of the second dorsal, the lower row from abreast the tip of the pectoral back about halfway toward a perpendicular at the origin of the pelvics. There also are a few black dots on the top of the head and others, wide spaced, in a single row along the mid-line of the back rearward to the caudal peduncle. But these black markings are so obscured by the generally dark color that those on the sides are discernible only here and there on the type, or on other specimens that have retained their color, while the dorsal dots are not to be seen on them at all. The teeth are white; the lining of the mouth is sooty to black, and the lining of the body cavity as well.

Size. A female 275 mm. long contains several large eggs (apparently not fertilized), and the claspers of the type specimen, of 270 mm., appear to be nearly full grown, suggesting a maximum length perhaps not much greater than 300 mm.

Luminescence. The black dots and dashes on the back and sides bear so close a resemblance to those of *E. spinax* and of *E. lucifer*[55] as to

[55]See Johann (1899, p. 136–160, Pls. 10, 11) for the luminescent organs and luminescence of *spinax;* Oshima (1911, p. 1) for *lucifer.*

suggest that they are luminescent in *schultzi* also. But we saw no sign of light emission by any of the specimens, even when first taken from the trawl.

Remarks. E. schultzi falls with *E. princeps* and with *E. pusillus,* among North Atlantic species, in its nearly plain dark coloration. But it differs conspicuously from *princeps* in a relatively much longer caudal fin, also in its fringed fins, in its bristle-like denticles, and in much smaller size at maturity; also in having the pale interocular spot which *princeps* lacks; from *pusillus* (with which it shares a uniformly denticulate internarial region and the pale interocular spot) in a considerably longer caudal, from both *princeps* and *pusillus* in its fringed fins and its soft, bristle-like dermal denticles. The nature of its denticles would seem to ally it to *spinax* and to *hillianus*, if this be regarded as a primary specific character. But it differs from both of these in its fringed fins; also in its plain coloration; further from *hillianus* in a much shorter tail sector of the trunk relative to the body sector; from *spinax* (which it resembles more closely in its proportional dimensions) in rounded pectorals, their outer margins falling far short of the first dorsal spine when the pectorals are laid back; and in that it lacks the black flank marks which are visible on *spinax* even in fresh specimens on which the back and sides are nearly as dark as the belly.[56] A relatively much longer caudal fin separates *schultzi* quite obviously from the new species *E. polli* (p.241); its lack of black flank marks is an equally precise differential character, though one less conspicuous, for these black markings are not easy to see on *polli* though regularly characteristic of that species.

Plain coloration, without conspicuous flank marks, combined with its bodily proportions, seem to ally *schultzi* the most nearly to *granulosus* and to *brachyurus*, among species of its genus of other seas. But its caudal fin is considerably longer, relatively, and the tail sector of its trunk relatively much shorter than those of *brachyurus;* while a longer caudal plus the fact that the space between its nostrils is denticulate separate it from *granulosus*. And there is nothing in the published accounts of *brachyurus* or of *granulosus* to suggest that the fins are fringed normally in either of these species, as they are in *schultzi*.[57]

[56]See Smitt (1895, p. 1163, Pl. 51, fig. 3) for description and excellent colored illustration of *spinax*.

[57]For descriptions and illustrations of *granulosus*, see Günther, 1880, p. 19, Pl. 2, fig. C; Barnard, 1925, p. 49; 1927, Pl. 2, fig. 8; and Smith, 1949, p. 58, fig. 50. For *brachyurus* see Smith and Radcliffe, 1912, p. 679, Pl. 52; and Fowler, 1941, p. 248.

Habits. Evidently this little shark is confined to water at least moderately deep, for the captures were all made at depths of between 210 and 400 fathoms. Beyond this, all that we know of its habits is that its food includes squids (field notes).

Range. So far known only from the northern part of the Gulf of Mexico, between latitudes 26°59′ and 29°20′N; and between longitudes 82°25′ and 96°07′W ("Oregon" Stations 270, 271, 279, 319, 321, 482, 542, 549). *E. schultzi* must be decidedly common at appropriate depths in this part of the Gulf for the total number of specimens taken was more than one hundred, of all sizes (field notes).

Etmopterus virens, n. sp.
Figures 6D, 10

Type. Adult male 203 mm. long, "Oregon" Sta. 501, northern part of Gulf of Mexico, Lat. 29°52′N, Long. 91°33′W, 220 fathoms, Dec. 11, 1951; U. S. National Museum No. 160,859. Also 42 others, males and females, including an embryo ready for birth, from the same general region, "Oregon" Stations 321, Lat. 29°27′N, Long. 87°19′W, 220 fathoms; Sta. 351, Lat. 29°13′N, Long. 88°00′W, 200 fathoms; Sta. 382, Lat. 29°12′N, Long. 88°08′W, 190–210 fathoms; and Sta. 489, Lat 27°44′N, Long. 85°09′W, 254 fathoms; in U. S. National Museum and Museum of Comparative Zoology.

Description. Proportional dimensions, in per cent of total length, of male of 203 mm. (type) and female, 153 mm.

Trunk at origin of pectoral: breadth 8.8, 7.8; height 8.4, 7.2.

Snout length in front of: outer nostrils 1.7, 2.0; mouth 11.1, 10.5.

Eye: horizontal diameter 5.7, 5.2.

Mouth: breadth 7.6, 6.9.

Nostrils: distance between inner ends 3.5, 3.3.

Labial furrow length: 4.0, 3.9.

Gill opening lengths: 1st 1.0, 1.0; 2nd 1.0, 1.0; 3rd 1.0, 1.0; 4th 1.0, 1.0; 5th 1.2, 1.3.

First dorsal fin: vertical height 2.5, 2.6; length of base 4.4, 4.6.

Second dorsal fin: vertical height 4.9, 3.9; length of base 6.9, 6.5.

Caudal fin: upper margin 23.2, 24.2.

Pectoral fin: outer margin 10.6, 9.5; inner margin 5.4, 5.2; width 7.4, 6.9.

Distance from snout to: 1st dorsal 32.5, 30.7; 2nd dorsal 55.6, 53.5; upper caudal 76.8, 75.8; pectorals 23.1, 21.5; pelvics 46.8, 47.0.

Interspace between: 1st and 2nd dorsals 18.7, 18.3; 2nd dorsal and caudal 14.3, 15.7; base of pelvics and caudal 21.2, 20.1.
Distance from origin to origin of: pectorals to pelvics 23.6, 25.4.

Body thickest at pectorals, narrowing rearward to thin caudal peduncle, its height at first dorsal (where highest) about 15 per cent as great as length of trunk to origin of caudal; its thickness at first dorsal about 75–80 per cent as great as its height there. Breadth of head at corner of mouth about as great as length of snout to mouth. Head to origin of pectorals a little more than $\frac{1}{4}$ (30%) of trunk to origin of caudal fin, its length about 1.2 times as great as length of interspace between first and second dorsals. Body sector, to cloaca, about 2.3 times as long as tail sector from cloaca to origin of lower caudal. Head flattened above, the nape elevated a little. Snout fleshy, its anterior contour forming an angle of about 90° with broadly rounded apex, its lateral outlines narrowed a little abreast of eyes, the pattern of mucous pores on its lower surface visible thanks to the nakedness of the skin there (see below, p. 259). Eyes about 1.7 times as long as high, and about $\frac{1}{2}$ as long as snout to front of mouth Spiracles about $\frac{1}{3}$ as long as eye, a little above mid-level of eyes, and behind latter by a distance about $\frac{1}{3}$ as great as length of eye. Nostrils close to anterior margins of snout as usual in this genus, about 60 per cent as long as eye, only slightly oblique, the lobe-like expansion of the inner anterior margin slender (even more so than in *E. schultzi*,) reaching across nasal aperture; inner subdivision of latter about twice as long as outer subdivision. Mouth very little bowed, occupying about 4/5 breadth of head, the labial furrows reaching inward only about 28 per cent of distance toward the respective symphysis, and each extending rearward and outward from corner of mouth as a well marked furrow for a distance about $\frac{2}{3}$ as long as horizontal diameter of eye. First to fourth gill openings between $\frac{1}{4}$ and $\frac{1}{3}$ (29%) as long as distance between inner ends of nostrils and about $\frac{1}{5}$–$\frac{1}{6}$ as long as eye; anterior margins concave but not enough so as to expose the gill filaments to view; fifth gill opening 1.2 times as long as first-fourth gills.

Teeth smooth edged, $\frac{34}{32}$ in type specimen, $\frac{29}{24}$ in female of 153 mm.; no median tooth in lower jaw in either case; upper teeth mostly with 5 cusps, occasionally with only 4 (1 lateral cusp on the one side, 2 on the other), the median cusp much the longest, the outermost cusp on each side very small. Lower teeth with cusps directed so strongly outward, toward the corner of the mouth, that the inner edges of the

functional row form an almost continuous cutting edge parallel with the jaw. Dermal denticles low, conical to thorn-like, moderately to strongly curved rearward, recalling those of *E. princeps* (p.248,Fig. 8E), and of *E. lucifer,* rather than those of *hillianus,* of *spinax,* or of *schultzi* (p. 253);on moderately expanded quadri-radiate bases more or less concealed in the skin; the denticles rather sparsely distributed on anterior parts of trunk in general in random arrangement, but with indefinite indications of a linear arrangement on sides rearward from level of second dorsal; more closely crowded on lower part of the sides and on the black dotted area of the abdomen than above. Skin on lower surface of snout as a whole back to mouth naked (an important specific character); likewise lower lip as well as skin in region of gill openings. Caudal fin rather densely denticulate along fleshy axis but naked along margins; the other fins denticulate only close in to their bases.

The fins are of the ordinary type, i.e. the margins not regularly fringed, but with edges so delicate that they are more or less frayed on all our specimens. First dorsal fin evenly rounded along anterior upper margin; its base nearly as long as the eye, its free lower margin about as long as base, its rear corner rounded, its origin (first sensible elevation above general profile of back) posterior to origins of pectorals by a distance about as long as from spiracle to fifth gill opening. Interspace from rear end of base of first dorsal to first sensible elevation of second dorsal about as long as from snout to second gill opening; or about $\frac{3}{4}$ as long as upper side of caudal fin. Anterior edge of visible base of second dorsal spine posterior to rear ends of bases of pelvics by a distance about $\frac{2}{3}$ as long as eye on adult as illustrated by the type, but very close behind rear ends of pelvic bases on small specimens. Posterior margin of second dorsal fin deeply concave, its rear corner slenderly pointed, the free lower margin a very little shorter than the eye, the base (measured from anterior base of spine) about as long as from spiracle to second gill opening, and about 1.4 times as long as base of first dorsal measured from anterior base of spine. Distance from rear end of base of second dorsal to origin of upper side of caudal about as long as from tip of snout to rear of eye, or about $\frac{3}{4}$ as long as interspace between first and second dorsals. Caudal about as long as head to origin of pectorals, its axis only slightly raised, its extreme breadth a little less than $\frac{1}{3}$ as great (29–30%) as its length; its upper outline weakly convex, increasingly so rearward; the tip obliquely truncate with rounded corner; lower posterior margin moderately con-

cave, without definite subterminal notch; the lower anterior corner rounded, a little produced; lower anterior margin weakly convex, about as long as from spiracle to fifth gill opening. Distance from origin of lower side of caudal fin to rear ends of bases of pelvic fins about $^{9}/_{10}$ as long as head to origins of pectorals, and a little longer than distance from origins of pelvics to axils of pectorals. Bases of pelvics about as long as base of first dorsal; the margins nearly straight, the outer anterior corner rounded, the rear corner narrowly pointed; rear end of bases of pelvics definitely anterior to anterior base of second dorsal spine on type specimen, but only slightly so on small specimens Pectorals nearly square-tipped, with rounded corners reaching when laid back nearly or quite to a perpendicular at base of first dorsal fin-spine; anterior margin of pectoral slightly convex, inner margin rather strongly so to axil; base strongly oblique, about $^{2}/_{3}$ (68–69%) as wide as anterior margin of pectoral. Claspers of mature male cylindrical, free only at their extreme outer ends from inner margin of pelvic fin, the tip with three hard thorns.

Color. Perhaps the most striking feature of this new species is its pattern of darker and paler markings, easier represented pictorially (Figs. 6D, 10) than described verbally. In general, the upper parts of the trunk are sooty brown above the level of the origins of the pectoral fins, darkest along the back, but interrupted on each side by two narrow longitudinal stripes of pale bluish gray, the one stripe high up on the side, bowing down a little below the second dorsal fin and reaching forward to over the first gill opening; the other stripe (paler and hence more conspicuous) running rearward from close behind the upper end of the base of the pectoral fin past the base of the respective pelvic fin where it unites with the upper longitudinal pale stripe. The members of the lower pair of pale stripes (one on each side) are interconnected across the black belly by a pale belt close in front of the pelvics (conspicuous in ventral view); also by a pale area of considerable extent behind the pelvics. There also is a pale yellowish oval spot on the upper surface of the head between the orbits (as in *pusillus*, in *hillianus*, in *schultzi* and in *polli*). The region of the gill openings is pale brownish gray; so, too, are comma-shaped patches extending downward from before and behind the gill openings; there is a pale oval patch behind each eye, and a considerable pale area on the lower surface of the rear half of the tail sector of the trunk. Contrasting sharply with these pale areas, the lower surface of the snout is very dark bluish gray or blue black; the lower surface of the head,

rearward from the mouth, is black, as is the belly also, back to the pelvics (except for the pale cross belt just mentioned). Other conspicuous black markings are: (A) a flank mark, in the form of a bar that extends above the pelvic along each side, forward to about even with the origin of the pelvics and rearward about as far as the rear end of the base of the second dorsal, with the flank marks of the two sides joining to form a black belt crossing the lower surface of the trunk a little rearward from the pelvics; (B) a second belt crossing the lower surface of the tail sector of the trunk a little in front of the origin of the caudal fin, and extending rearward along each side in the shape illustrated (Figs. 6D, 10); and (C) a narrow stripe on either side along the lower edge of the caudal axis near the tip of the latter. The tip of the caudal fin is blackish, also, as is its lower anterior corner. But the other fins as a whole are pale gray, and with their outer parts translucent. The lining of the mouth is sooty to black, also the lining of the body cavity; the teeth are white. One of the most interesting characteristics of *virens* is that the belly of fresh-caught specimens shines with bright green iridescence, hence the name we propose for it. But this is entirely lost after preservation in alcohol.

The dark hue of the upper parts of *virens* in general, of the lower surface of the snout, and of the corners of the caudal fin is due to ordinary pigmentation. But the dark hue of the lower surface rearward from the mouth to the pelvics, and of the markings on the sides on the tail sector of the trunk result chiefly from the presence of great numbers of inky black depressions of the skin, irregularly roundish in shape, and of various sizes, but large enough on the whole and loosely enough scattered, to be visible individually under an ordinary hand-lens. The paler skin between them is richly provided, too, with much smaller black spidery chromatophores. And the black peritoneum, showing through the body wall, plays its part, likewise, in producing the black of the belly. Besides the broad-scale black areas just outlined, each side of the trunk is marked from the origin of the pectoral fin back to the origin of the caudal fin, with a complex series of black dots and narrow black dashes as follows: A) in a longitudinal row (double for part of its length) following the upper edge of the lower of the two pale side stripes from close to the axil of the respective pectoral fin to above the origin of the pelvic fin; B) in a shorter longitudinal row midway up each side, from below the first dorsal fin to above the origin of the pelvic fin; C) in a double row running along, close above the upper pale side stripe from below the first dorsal fin

to below the rear end of the base of the second dorsal whence it continues rearward as a single row as far as the origin of the caudal fin. There also are two groups of longitudinal black dashes on each side of the head between the eye and the first gill opening, the one group behind the other, with each group consisting of 3 dashes, one above another. Small specimens also have a mid-dorsal row of dots (the successive dots so close together as to form a nearly continuous line) extending forward from the origin of the first dorsal fin nearly as far as the spiracles; also a loose cluster of black dots close behind the pale interocular spot, with another such cluster in front of the latter and partially enclosing it. But the heads of the larger specimens show only faint traces of these mid-dorsal markings.

Microscopic examination shows that each of these black dots and dashes actually represents either a pit or a trough-like depression of the skin, in which they agree with the similar black markings on the sides and back of *E. spinax* and of *E. lucifer*.[58]

Size. The facts that the claspers of the type specimen 203 mm. long, and those of another male of 225 mm. appear to be fully formed and in functional condition, and that a female of 230 mm. contained an embryo 45 mm. long and about ready for birth show that this is one of the smallest of known sharks, and suggest a maximum length perhaps not greater than 300 mm.

Luminescence. The black pits and furrows on the back and sides of *E. virens,* like the similar structures on *E. schultzi* (p. 255) recall the luminescent organs of *E. spinax* and of *E. lucifer* (p. 255, Footnote). And while we saw no signs of the emission of light by *virens,* any more than by *schultzi* (p. 256), the possibility remains that they may so function, for the specimens that were in the best condition were all taken during the daytime.

Remarks. Among North Atlantic species, *virens* falls the most nearly with *hillianus* in its proportional dimensions and in its color. But it differs quite sharply from *hillianus* in its low, conical denticles (bristle-like in *hillianus*); in the nakedness of the skin on the lower surface of its snout and in the region of its gill openings (rough with denticles in *hillianus*); and in a shorter snout, the distance from its tip to the level of the spiracles being about as long as from spiracles to axils of the pectorals in *hillianus,* but only about as long as from spiracles to origins of pectorals in *virens.* A still more conspicuous difference lies in the shapes of the black markings on the sides of the rear part of the

[58] See footnote 55, p. 255.

trunk in the two species (Fig. 6), while the freshly taken specimens of *hillianus* that we have seen showed no trace of the green iridescence that is so conspicuous a feature of the belly of fresh-caught *virens* (p. 261). Among species of *Etmopterus* from other seas, *virens* falls the nearest to *lucifer* in the great length of the tail sector of its trunk, and in its color pattern. But it differs from *lucifer* a) in lower and stouter dermal denticles; b) in a longer caudal fin (about 1.3 times as long as interspace between first and second dorsals in *virens;* only about 90 per cent as long as interspace between dorsals in *lucifer*); c) in the shape of its nasal flap (Fig. 10C), that of *lucifer* being broadly triangular, i.e. more nearly as it is in *princeps* (Fig. 8C); d) more conspicuously in the shapes of the black markings on the posterior part of the trunk (Fig. 6).

Habits. All that is known of the habits of this little shark is that it appears to be confined to at least moderately deep water, all the specimens yet seen having been trawled between 190 fathoms and 254 fathoms; and that it feeds on squids.

Range. Known only from the northern side of the Gulf of Mexico, at the stations listed (p. 257); but evidently quite common there, at suitable depths, for we saw more than a hundred specimens taken from the trawl, of all sizes.

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Fig. 1. *Apristurus atlanticus* Koefoed 1932. Female, 297 mm. long, northern part of Gulf of Mexico, Lat. 27°32′N, Long. 93°02′W, 400–450 fathoms, "Oregon" Sta. 534.

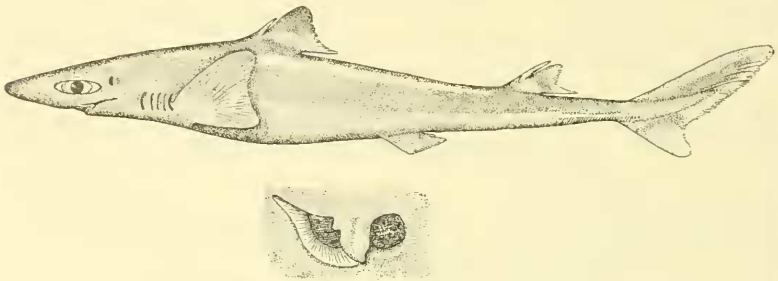

Fig. 2. *Squalus fernandinus* Molina 1782. Juvenile male, 395 mm. long, off South Carolina, Lat. 33°00′N, Long. 77°07′W, May 1949, collected by "Albatross" III. Below, left-hand nostril of same, x about 3.

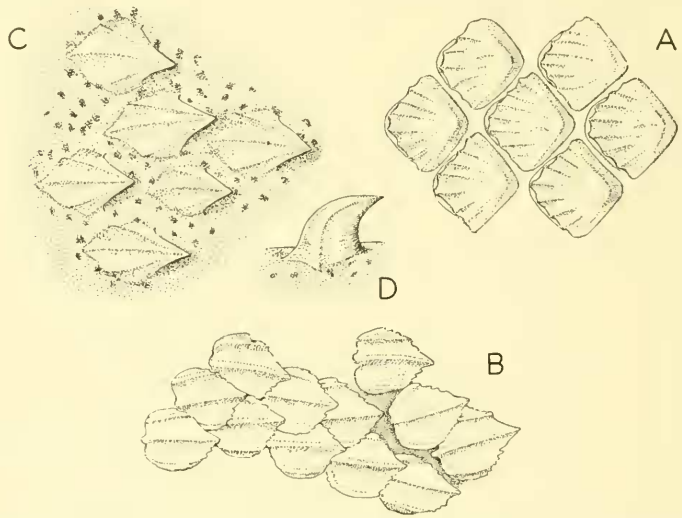

Fig. 3. Dermal denticles of three species of *Centrophorus*, from side, below first dorsal fin. A: *granulosus* Bloch and Schneider 1801, specimen in Museum of Comparative Zoology, x about 12. B: *squamosus* Bonnaterre 1788, 1200 mm. long; west of Iceland, specimen in Museum of Comparative Zoology, x about 6. C–D: *uyato* Rafinesque 1810, female, 445 mm. long, northern part of Gulf of Mexico, Lat. 29°17′N, Long. 87°42′W, 208 fathoms, "Oregon" Sta. 515, x about 40.

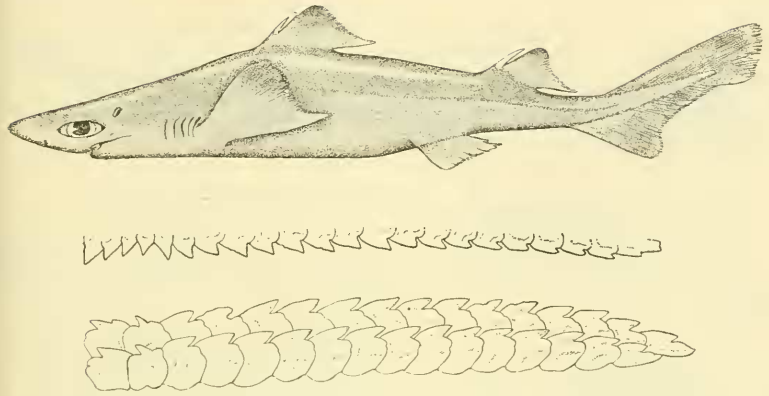

Fig. 4. *Centrophorus uyato*(Rafinesque)1810. Juvenile male, about 429 mm. long, northern part of Gulf of Mexico, Lat. 29°17′N, Long. 87°42′W, 208 fathoms, "Oregon" Sta. 515. Below: upper and lower tooth bands of left-hand side of mouth, viewed from anterior side,of female 445 mm. long, same specimen as in Fig. 3C, x about 3.4.

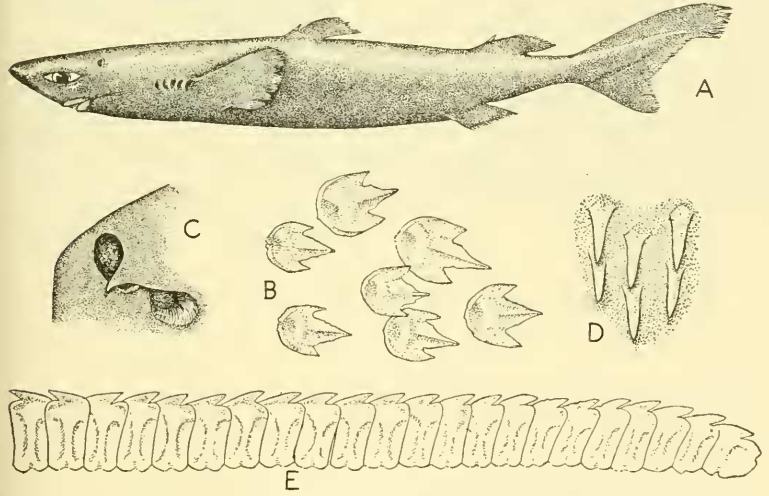

Fig. 5. *Scymnodon melas*, n. sp. A: type specimen, 462 mm. long, continental slope off Georges Bank, Lat. 40°00′N, Long. 68°52′W, 420–480 fathoms, July 12, 1952, Museum of Comparative Zoology No. 37452. B: group of dermal denticles of same from side below first dorsal fin, x about 10. C: right-hand nostril of same, x about 2. D: teeth of same from upper jaw, near center, x about 4. E: lower tooth band of same, from right-hand side of mouth, anterior view, x about 4.

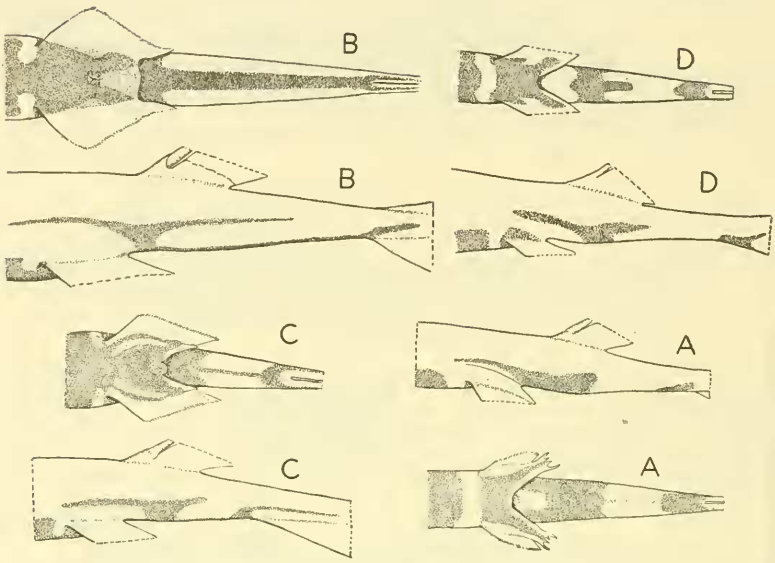

Fig. 6. Black pattern on posterior part of trunk in different species of *Etmopterus*. A: *E. hillianus* Poey 1861; north coast of Cuba, x about 0.4. B: *E. lucifer* Jordan and Snyder 1902, Japan, x about 0.4. C: *E. spinax* (Linnaeus) 1758, Norway, x about 0.4. D: *E. virens*, n. sp., type specimen; northern part of Gulf of Mexico, x about 0.4.

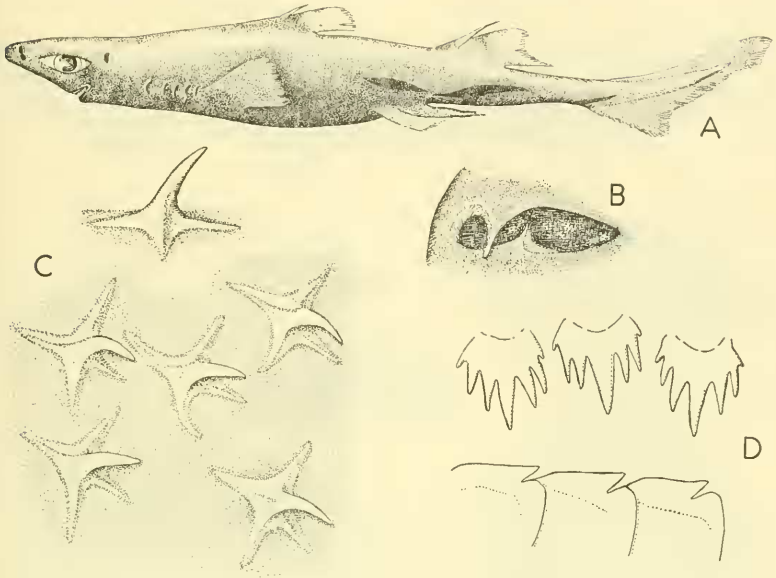

Fig. 7. *Etmopterus polli*, n. sp. A: type specimen, 197 mm. long, off equatorial West Africa, Lat. 6°08′S, Long. 11°24′E, 350–380 meters, Museum of Comparative Zoology No. 38001. B: right-hand nostril of same, x about 5. C: dermal denticles of male, 232 mm. long, from same locality as the type specimen, x about 45. D: upper and lower teeth of male, 197 mm. long, same locality as type specimen, about midway between symphysis and outer corner of mouth, x about 14.

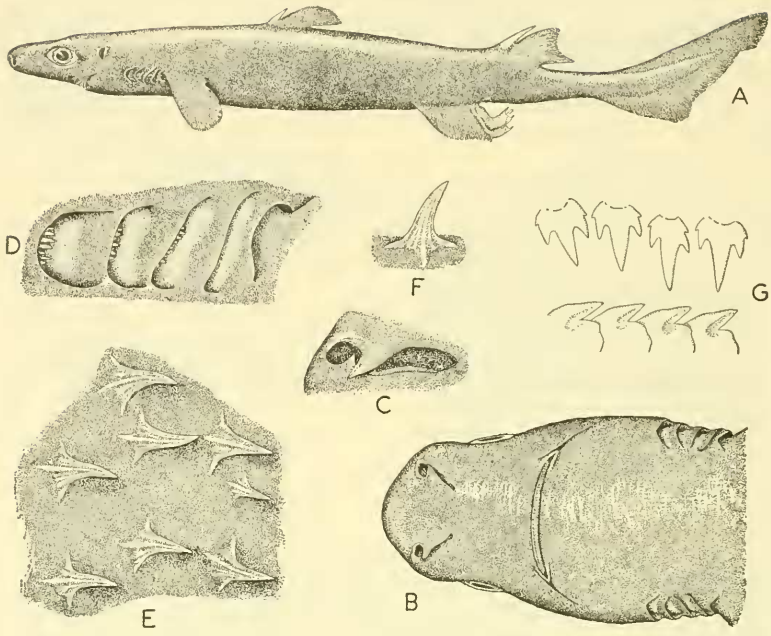

Fig. 8. *Etmopterus princeps* Collett 1904. A: adult male, about 545 mm. long, off southern Nova Scotia, Lat. 41°25′N, Long. 65°56′W, 400–490 fathoms, tip of snout somewhat restored from a slightly smaller specimen from nearby. B: lower surface of snout of same, x about 0.4. C: right-hand nostril of same, x about 1.2. D: gill openings of same, left-hand side, x about 1.2. E: group of dermal denticles of same, from side below first dorsal fin, x about 15. F: side view of a dermal denticle of same, x about 15. G: upper and lower teeth of same, about midway between symphysis and corner of mouth, x about 4.

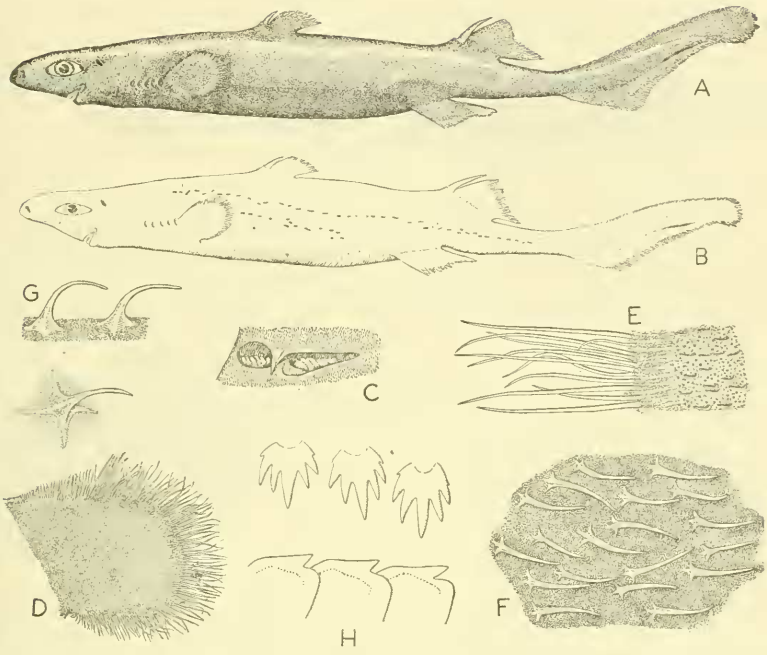

Fig. 9. *Etmopterus schultzi*, n. sp. A: type specimen, 270 mm. long, northern part of Gulf of Mexico, Lat. 29°11′N, Long. 86°53′W, 305 fathoms, "Oregon" Sta. 279, U. S. National Museum No. 113,381. B: outline drawing of same showing the black dashes and dots, perhaps luminescent. C: right-hand nostril of same, x about 3. D: left-hand pectoral fin of adult male about 280 mm. long, "Oregon" Sta. 549, x about 1.2. E: margin of pectoral of same, to higher scale, to show free, fringe-like terminations of the horny rays, x about 6. F: group of dermal denticles of same, from side below first dorsal fin, x about 22. G: dermal denticles of same in side view, and viewed obliquely with base freed from the skin, x about 24. H: upper and lower teeth of male 245 mm. long from about midway between symphysis and outer corner of mouth; "Oregon" Sta. 542, Lat. 27°41′N, Long. 94°59′W, x about 10.

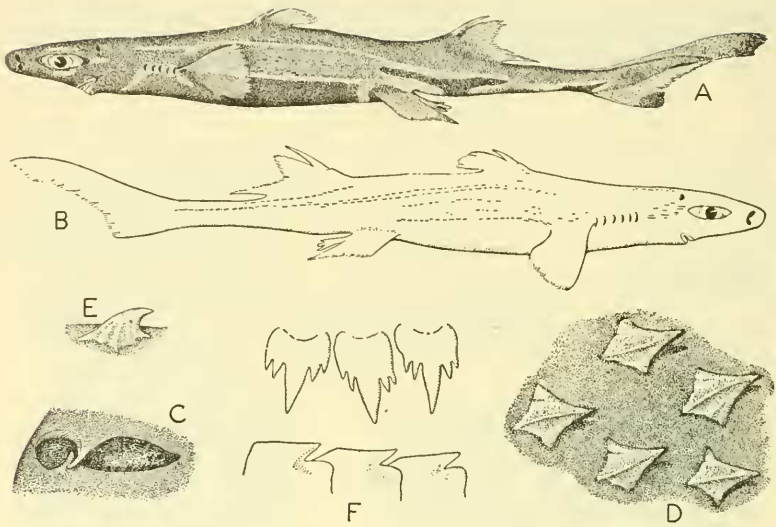

Fig. 10. *Etmopterus virens*, n. sp. A: type specimen, 203 mm. long, northern part of Gulf of Mexico, Lat. 29°52′N, Long. 91°33′W, 220 fathoms, "Oregon" Sta. 501; U. S. National Museum No. 160,859. B: outline drawing of right-hand side of same, to show the pattern of black dots and dashes, perhaps luminescent. C: right-hand nostril of same, x about 3. D: group of dermal denticles of another specimen of about the same size, from the side below the first dorsal fin, x about 36. E: dermal denticle of same in side view, x about 36. F: upper and lower teeth, from about midway between symphysis and corner of mouth, x about 10.